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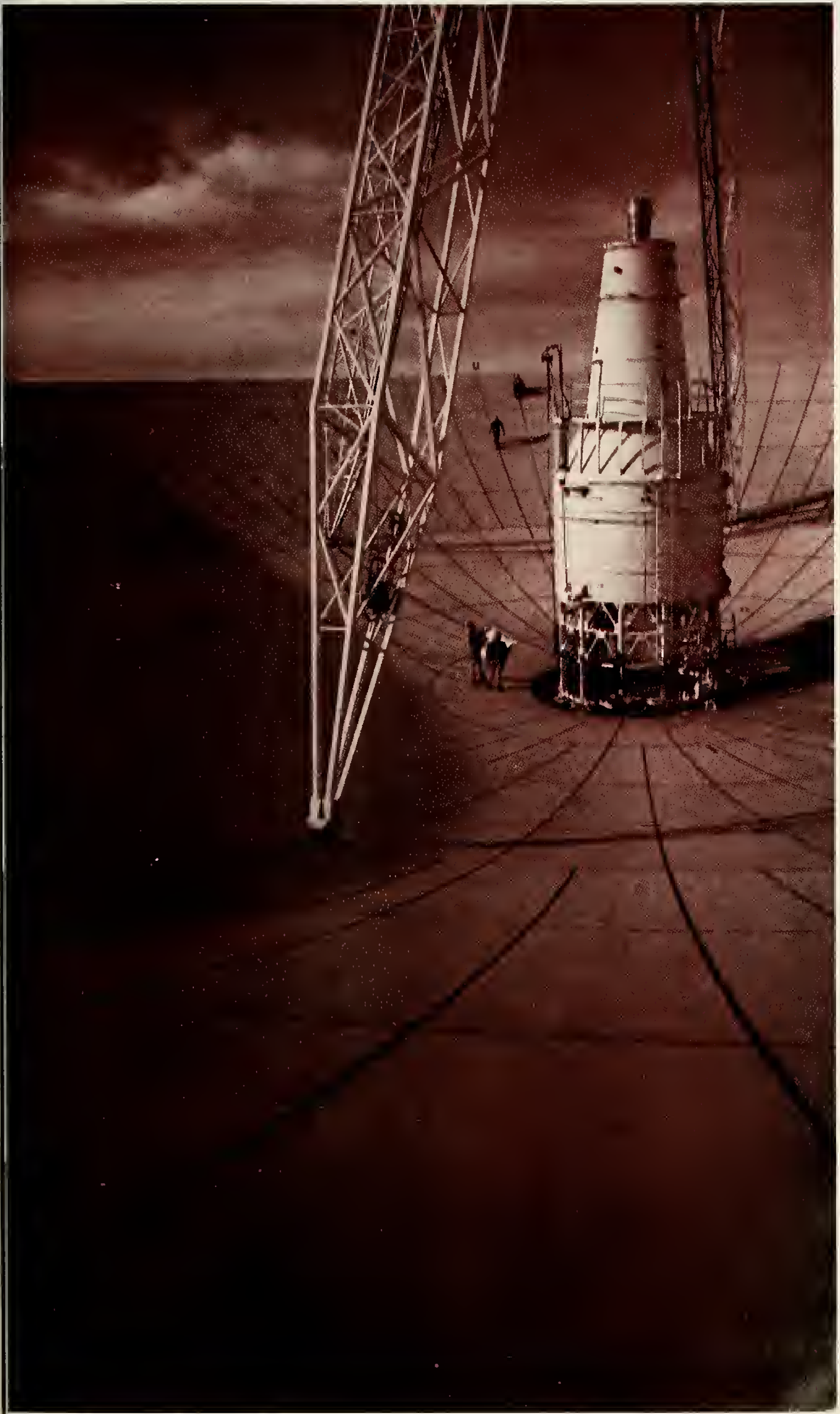

nicians at Work on New Goldstone Antenna

McNamara Discounts Effectiveness Of Any Soviet ABM

Multi-Purpose DOD Satellite Plan

High Hopes For Deep Quest

New Facility for Guidance Testing

AN AMERICAN AVIATION

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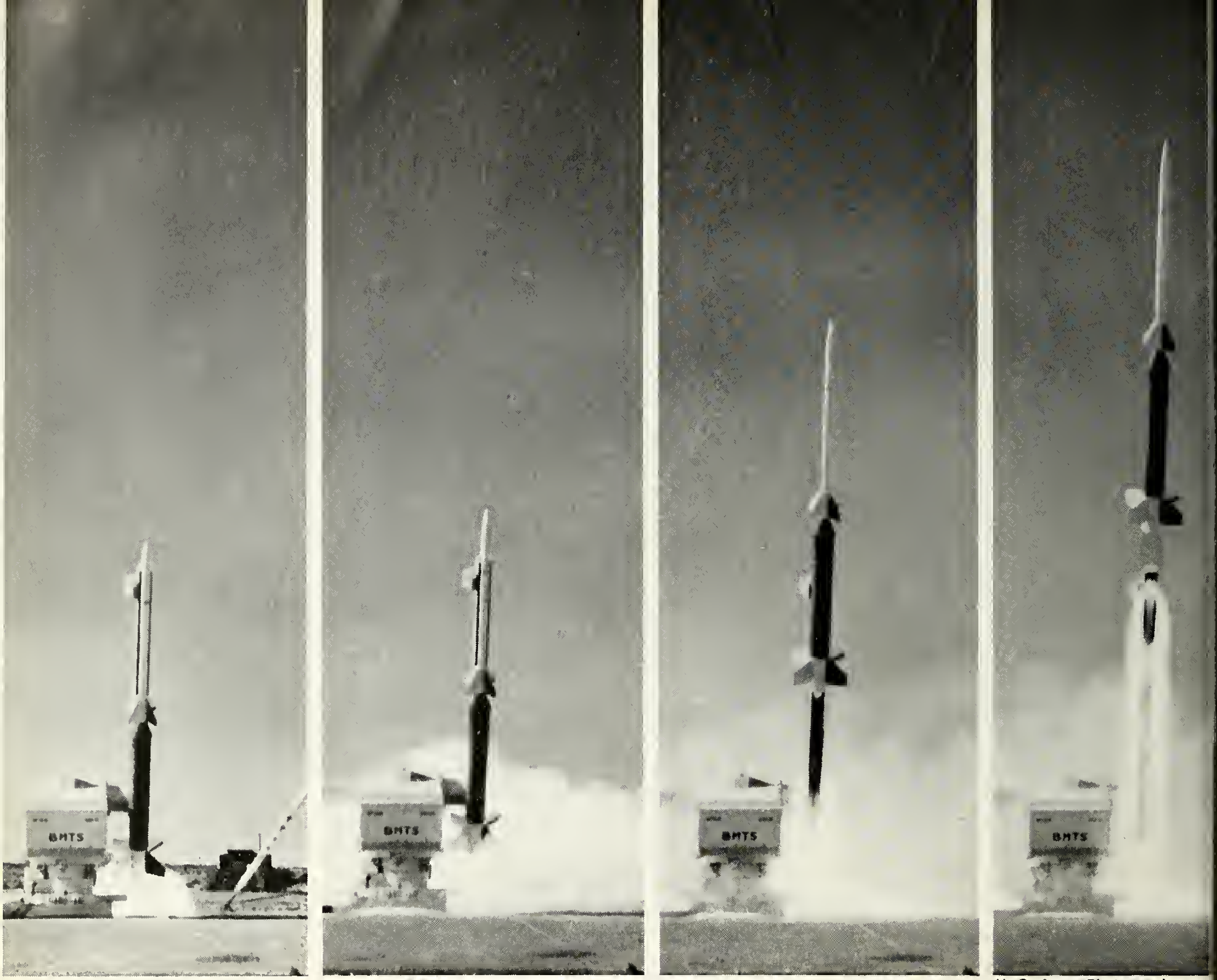

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missiles and rockets

THE WEEKLY OF ADVANCED TECHNOLOGY

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THE COVER

Technicians are dwarfed by 210-ft.-dia. steerable antenna at NASA/JPL's Goldstone, Calif., site. Due to be operational within two months, it will track spacecraft out to the orbit of the planet Pluto. Antennas of similar size are to be built at other Deep Space Network sites. Rohr Corp. is prime contractor. See page 34.

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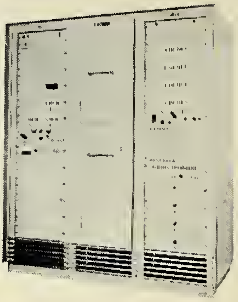
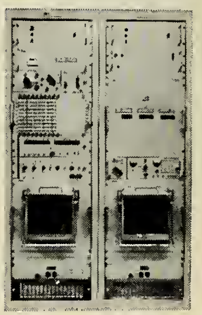
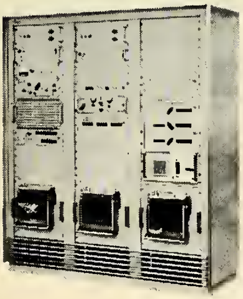

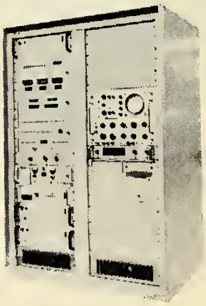
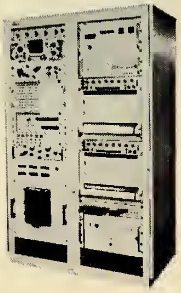
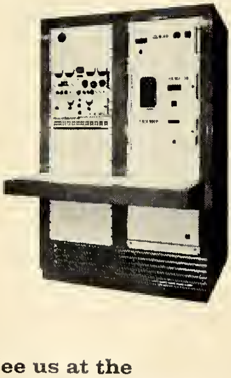
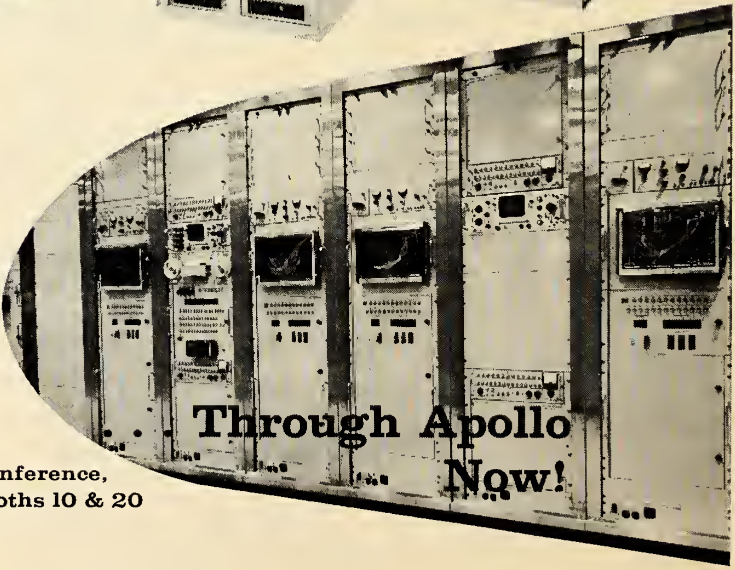

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The Countdown

WASHINGTON

Policy Decisions Delay ATM Requests

Still-hanging NASA policy decisions are the cause of the delay in issuing requests for proposals for the $80-million *Apollo* Telescope Mount (ATM) program. They include whether the Office of Manned Space Flight or Space Sciences and Applications will direct development, which field center will have responsibility for the development, and whether ATM will be placed in the Command Module or Lunar Excursion Module. After an effort by Deputy Administrator Robert C. Seamans to solve the differences about two weeks ago, the matter now is in the hands of Administrator James E. Webb for final solution. Further delay of two to three weeks is expected. It now appears almost impossible to make the late 1968 launch date for ATM.

High Commonality Seen in New Aircraft

Two important new military aircraft now under consideration by Dept. of Defense, Navy's VFAX and Air Force's FX, both high-performance fighter/attack aircraft, should have a commonality higher than the two versions of the F-111 on weight, performance and mission characteristics. That's the word from Air Force Secretary Harold Brown. Noting that the specifications appear to be more similar than in the case of the controversial F-111, Brown also believes there will be fewer engineering problems than encountered when introducing such innovations as the variable sweep wing and fan engines of the F-111. Brown says that while the FX is further along at this time, it is not so advanced that the two aircraft cannot move into the same time frame.

NASA Seeks New Diodes for Lasers

NASA's Manned Spacecraft Center is sponsoring a program to grow and produce gallium arsenide laser diodes specifically for its proposed second-generation pulsed laser transmitter, which is to be flown as part of a laser communications experiment on *Apollo.* According to the request for proposals, the one-year development program is aimed at producing "more desirable" laser diodes. Listed as specific areas for improvement: power output, operational lifetime, spatial uniformity of beam output, duty cycle and thermal effects. Bids are due at MSC by May 16.

Gen. Sands Learns a Lesson

Maj. Gen. Harry J. Sands, Jr., returns to his post as commander of Air Force Ballistics Systems Div. this week. His tour there was interrupted by six months of temporary duty in Korea as senior member of the United Nations Military Armistice Commission. Sands, writing to his former BSD staff, says that he "went to his first session with the naive faith that some real sincerity on our part would beget some of the same on theirs . . . I learned better."

Schriever Departure: A DOD View

Resignation of Air Force Systems Commander Gen. Bernard Schriever, whose thinking long has conflicted with some top-level Dept. of Defense policies, is not drawing many tears from DOD although high officials elsewhere have expressed regret. Says one DOD official: "We'll see some necessary changes at Systems Command now."

AAP Proposals Sent Back to Huntsville

NASA Headquarters has sent industry proposals on *Apollo* Applications Program systems definition back to Marshall Space Flight Center for further review. This should be concluded late this week. Nine firms submitted proposals. Two or more firms are to be chosen to carry out the systems definition phase.

Mariner Subcontract RFP's Upcoming

NASA hopes to have requests for proposals on one-half of the 12 subcontracts for the *Mariner* '69 spacecraft out by the end of June. Remaining six are to be issued by the end of October.

INDUSTRY

SAM-D Bidder List Increases

At their request, four additional firms have been added to the bidders' list for the Army's *SAM-D* air defense system (M/R, April 25, p. 11). The firms are Sylvania, Litton, International Telephone and Telegraph, and General Dynamics. GD is expected to team with General Electric, one of the seven firms originally asked to bid on the system. Martin-Orlando, long active in this field, is teamed with Raytheon, another of the original seven.

MOL Data System Contract Decision Due

Selection of either IBM or Sperry Rand to provide the data management subsystem for the Air Force's *Manned Orbiting Laboratory (MOL)* program is expected about May 16.

INTERNATIONAL

Soviets Disguise Missile Tests

Soviet Union has announced "space booster" tests for the Pacific in July, but like all previous such tests, these are expected to be flight tests of ICBM's. In all earlier tests, three Russian tracking ships have ringed the target area and fiery nose cones have been observed impacting into the water. The space booster explanation is used to hide the military nature of the tests.

Russian Orbit-Changing Doubted

Administration officials report that the Soviet Union still has not demonstrated effective orbit-changing capability. They note that the *Polyot II* spacecraft, which is expected to re-enter the atmosphere in late May, was able to change its inclination by one or two degrees. The satellite—designed to test rendezvous techniques—is said to be far below *Gemini* in capability. In addition, although the Russians said a long series of *Polyots* would be launched, only one has been orbited in two years.

NASA Review Board Set Up

Stung by the recent failure of its first *Orbiting Astronomical Observatory* (*OAO*), NASA has established a five-member board to conduct a broad review of its observatory-class Earth satellites.

In addition to the first *OAO* failure, two *Orbiting Geophysical Observatory* (*OGO*) satellites have experienced attitude control problems in orbit. The *Orbiting Solar Observatory C*, launched Aug. 25, failed to go into orbit.

The Observatory Class Spacecraft Review Board was named by Dr. Homer E. Newell, associate administrator for space sciences and applications.

Chairman of the board will be Robert F. Garbarini, deputy associate administrator for space sciences and applications (engineering).

The *Orbiting Astronomical Observatory I* failed on April 10, two days after its launch from Cape Kennedy, Fla. Project officials are studying why the main battery overheated and caused *OAO*'s power system to fail.

Schriever To Leave AFSC

Gen. Bernard A. Schriever, chief of the Air Force Systems Command since it was established seven years ago, will retire effective Aug. 31.

Lt. Gen. James Ferguson, presently deputy chief of staff for research and development, has been named to replace Schriever, the White House has announced. Ferguson has been recommended for four-star rank to take effect Sept. 1.

Schriever, 56, said he was retiring for personal reasons and reportedly has no plans for the future. Feeling at Systems Command is that he will serve in some Air Force or Government advisory capacity because of his very broad operational and technical interests, rather than confine himself to the comparatively narrow pursuits which could be exercised with only one company. This is only speculation, AFSC spokesmen stressed.

Missiles Score in Vietnam

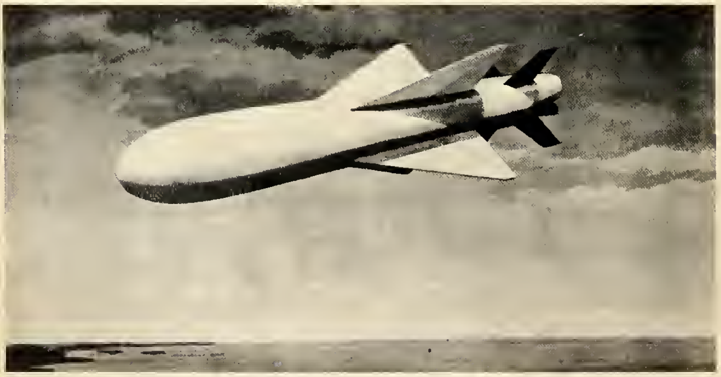
U.S. *Sidewinder* missiles accounted for one Mig-17 and one Mig-21 in air-to-air combat over North Vietnam last week.

A *Sparrow III* missile also was credited with downing another Mig-17. Before the *Sidewinder* kill of the high-performance Mig-21, two Air Force F-4C's tangled with Mig-21's in a battle during which 10 or 11 U.S. missiles were fired without finding any mark.

Still unanswered is the question of the nationality of the pilots flying the Mig-21, one of the most advanced Soviet-built fighters. While the existence of these craft in North Vietnam has been known for some time (M/R, March 28, p. 56), it has never been clear as to whether Russians, North Vietnamese or Chinese pilots fly them. Speculation at this time centers on the Russians.

Condor Missile Under Development at North American

Contract for development of the TV-guided Condor missile, shown here in artist's concept, is being negotiated by the Navy and North American's Columbus Div. The air-to-surface missile, designated AGM-53A, is designed to provide aircraft with an advanced launch capability and greater bombing accuracy. Rocket-powered and carrying a conventional warhead, it is adaptable to current and future planes.



Shots of the Week

- The Soviet Union has begun a new series of rocket tests into two target areas in the Pacific Ocean. The tests, scheduled to last through July 31, are confined to two 40-mi.-dia. areas, one located west of Midway Island and one northeast of Wake Island. Foreign ships and aircraft have been warned to stay out of the areas between noon and midnight, local time.
- Russia launched its third communications satellite, *Molniya I*, on April 25. The spacecraft has successfully transmitted good-quality pictures between Moscow and the Far East, Tass reported.
- Three *Polaris A-3* missiles were successfully fired April 21 from the USS George Bancroft, submerged 30 mi. off the coast of Cape Kennedy.
- The *OV3-1* satellite was launched aboard a *Blue Scout* booster from Vandenberg AFB, Calif., on April 22. The 152-lb. satellite, designed to study charged particles in the Earth's magnetic field and upper ionosphere, was placed in a polar orbit.
- The *Cosmos 116* scientific satellite was launched by the Soviet Union on April 26.

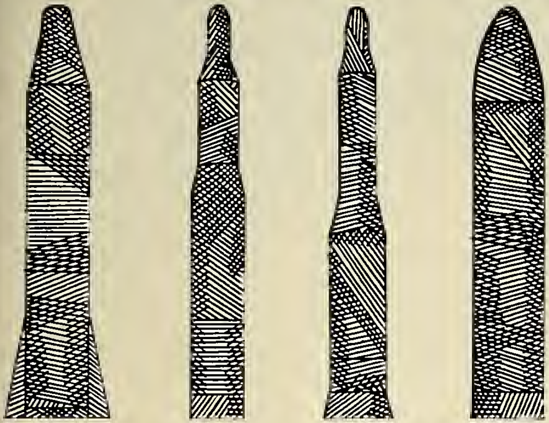
AC-8 Failure Pinpointed

A malfunctioning attitude control system is blamed by the space agency for the failure of *Centaur 8* to restart its engines in space on April 7.

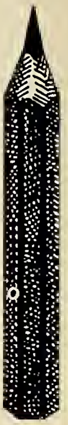
NASA said that one or more of the small attitude control jets apparently used excessive amounts of hydrogen peroxide gas, causing an early depletion of the system's fuel supply.

Thus, after the engines ignited, boost pumps which provide required pressures for the *Centaur* propellant flow, did not continue to receive sufficient hydrogen peroxide and shut down. As a result, one RL-10 engine operated at full thrust for a few seconds while the second engine developed only a very low pressure and shut down.

NASA said that the failure will



HOW WILL POSEIDON DIFFER FROM ATLAS, TITAN, MINUTEMAN – AND POLARIS?



In many respects, like day and night. In its ability to penetrate enemy defenses. In its operational flexibility. And in other aspects which will make Poseidon an unequaled deterrent. But attaining these advances presents problems never before encountered in a ballistic missile program. The demand for new concepts is urgent. Engineers and scientists interested in contributing to a long-range program which is now in its early stages are invited to write or send resume to: K. R. Kiddoo, Professional Placement Manager, Sunnyvale, California. An equal opportunity employer.

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in no way affect the upcoming *Atlas/Centaur 10* mission, which is designed to send a *Surveyor* spacecraft on a lunar soft landing flight late in May. That flight will only require the *Centaur* to burn once.

On the Feb. 7 flight, the *Centaur* did ignite once as it placed a dummy *Surveyor* spacecraft in a 100-statute-mile parking orbit. It was then that the attempt to re-ignite the engines failed.

Investigation is continuing to determine the reason for the unexplained loss of hydrogen-peroxide which resulted in shut-down of the boost pumps and subsequently the main engines.

An important objective of the *AC-8* flight—that of providing, for the first time, a method of controlling the behavior of high-energy propellants during zero-g coast in space—was successfully achieved.

Defined Comsat Pact Advances

The final contract for the Communication Satellite Corp.'s advanced global satellite system has been approved by the international comsat consortium and sent to the Federal Communications Commission.

Negotiations between Comsat and TRW Systems Group for the fixed-price-plus-incentive contract, totaling almost $32 million, were completed last week (M/R, Dec. 20, p. 19). Major subcontractor to TRW is ITT Federal Laboratories, which is expected to receive from $10 to $12 million for spacecraft electronics.

The contract calls for an initial six satellites, plus two engineering models and one prototype model, with options to purchase up to 18 more satellites. Delivery is requested within two years for the first six spacecraft, and deployment is planned for 1968.

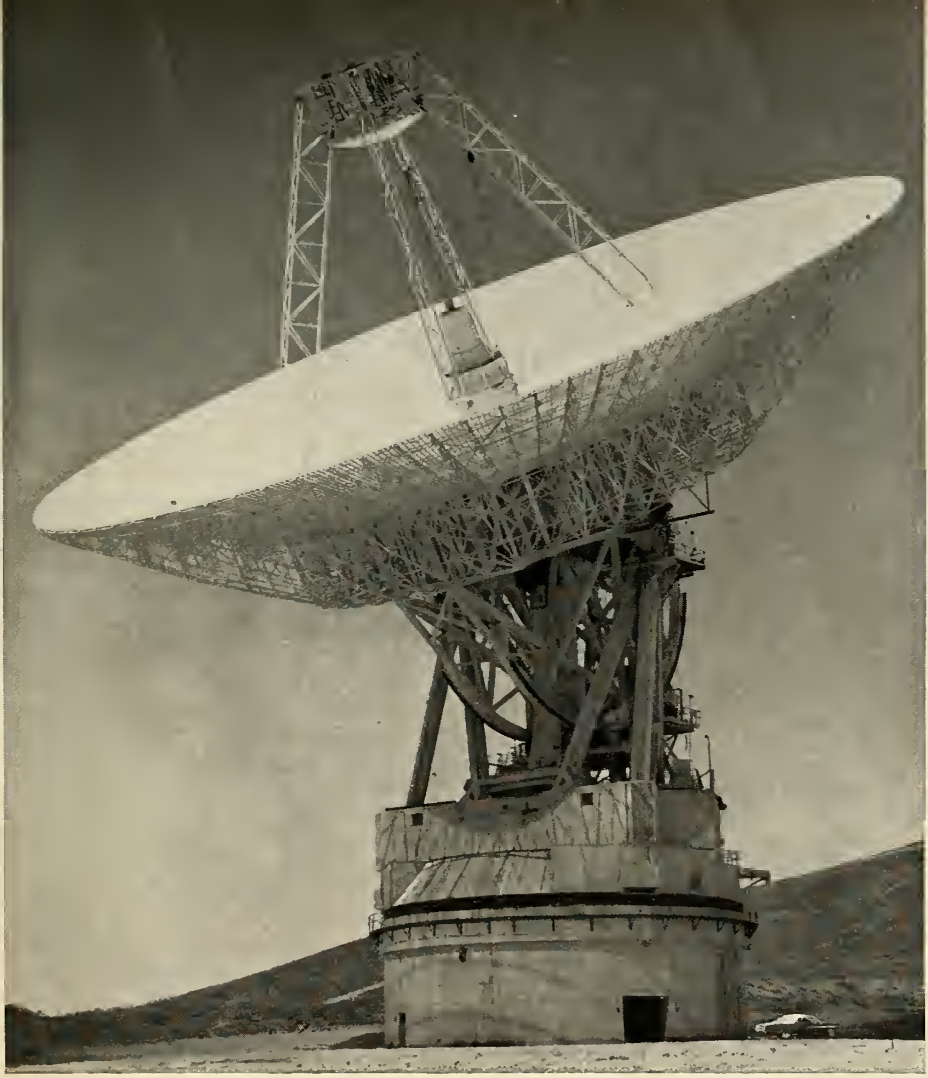
More than six foreign firms are expected to receive subcontracts from TRW or ITT, as are other U.S. companies.

Saturn S-II Static-Tested

The second static-test of the *Saturn V* S-II stage is planned within the next three weeks following a 15-sec. static firing April 23.

The firing at the Mississippi Test Facility was termed near-perfect. Officials from NASA and North American Aviation, who conducted the test, were evaluating results last week to determine how soon the program could go into its second phase.

The three-test series is planned to qualify the stage and test stand.



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McNamara Says Soviets Err on ABM

by Michael Getler

WASHINGTON—Despite an assumption by Defense Secretary Robert S. McNamara that the Soviet Union "will deploy an anti-ballistic missile system," and mounting evidence that indicates they are going about it, the Defense Department is not expected to alter its position regarding deployment of the *Nike-X* system to counter a Soviet ballistic missile threat to this country.

This does not preclude a DOD decision to move ahead with a light-attack version of *Nike-X* against the Chinese.

The DOD reponse to any verified Soviet ABM system continues to be stepped-up improvements to the U.S. offensive missile force to insure its ability to penetrate.

This effort is currently embodied in the replacement of the 800-missile *Minuteman I* force with *Minuteman II* ICBM's, and accelerated development of *Minuteman III* and *Poseidon* submarine-launched ballistic missiles.

Further along, this course of action is expected to lead to the full-scale development, beginning possibly next year, of a new, very large and sophisticated ICBM, the *Improved Capability Missile* (*ICM*) which would be equipped with a highly maneuverable re-entry package and multiple nuclear warheads (M/R, April 11, p. 12).

Secretary McNamara asserted at a press conference last week that "if we had to spend the entire budget of the Defense Department, $50 billion, on the strategic offensive system, we would propose to do so to insure that the Soviets do not develop an effective counter."

The Secretary, in response to a MISSILES AND ROCKETS query regarding the logic behind a Soviet decision to build an ABM system, viewed such a decision "if they have decided that" as "simply a carry over of the same philosophy into ABM defense that they made in connection with air defense. And, I think, with the same error."

Defense fruitless?—"The Soviets for years," the Secretary said, "have placed a different emphasis on strategic defense than we have. They have felt that they could obtain a higher level of protection than we believed was technically feasible. For that reason, they have been spending, I would say for a decade and a half, perhaps two and a half times the amount we have on air defense."

Other defense and Government officials view the apparent Soviet commitment to an ABM system also as an extension of the traditional obligation of the USSR to defend itself in whatever way possible from an attack by the U.S., despite a realization that any ABM system would at best be partially successful.

Defense Secretary McNamara, who last week reiterated confidence in U.S. ICBM's.

A comparison of strategic strike forces would tend to indicate that the U.S. not the Soviet Union, would be in a better position to gain at least some advantage by even a partially effective ABM system.

The USSR is now credited with roughly 270-300 ICBM's and perhaps 100 operational submarine-based ballistic missiles (M/R, April 4, p. 12). Given even a rapid rate of Soviet ICBM growth in the next five years (a feat which would undoubtedly be difficult if funds for an ABM system are to be made available), the U.S. in 1971 would still be faced with a far smaller Soviet force to contend with than the 1,710 operational ICBM's the Secretary says will make up the U.S. force at that time.

A direct comparison is misleading, however, principally because of the no-first-strike posture of the U.S. Exactly how the scenario of a nuclear exchange would unfold after an initial holocaust and what then would be the effectiveness of a Soviet ABM system remains the product of intelligence and analysis.

There is also the possibility that the Soviet ABM system may be deployed only around Moscow and Leningrad, in an attempt to center protection around its two key cities. Recent reports from Moscow (M/R, April 4, p. 7) indicated that the new large structures believed to house ABM radars sighted in the Soviet countryside have been seen thus far only around those cities.

The Secretary, at the press conference called primarily to refute charges made by a Congressional subcommittee investigating the manned bomber situation, reiterated his strong belief in the ability of U.S. missiles to "survive an enemy's surprise attack and to penetrate any defensive system he may have with sufficient strength to insure complete destruction of that nation.

"We see no Soviet system on the horizon . . . within the limits of the period of the program that we are dealing with (through 1971) which could in any way prevent our ICBM's from achieving their objective . . ."

Assurances unassuring—Despite the Secretary's assurances, there remains considerable uneasiness over the developing ABM situation.

For one thing, the Soviets have probably been at work on ABM systems longer that has the U.S. Given their proclivity for strategic defense and their admittedly large expenditures, there is a strong tendency among many military and civilian observers not to underestimate Soviet ABM capabilities.

Also, there is the likelihood that if the Soviets believe in their system enough to spend billions of rubles for it, there is also the likelihood that they believe it will work, despite statements from the U.S. Administration that it won't.

Combined with a first-strike posture, this could lead to a highly destabilized military situation.

Finally, and most important, is the fact that with a shelter program, a U.S. ABM could probably save 40 million lives or more.

The uneasiness was reflected in actions last week in both houses of Congress.

During the House subcommittee hearings on the manned bomber questions, several Air Force generals, admittedly on the side of a new manned bomber to perpetuate the mixed force of bombers and missiles beyond the early 1970's, nevertheless raised anew some of the old questions.

Retired Air Force Gen. Curtis LeMay, former chief of staff, told the committee in February: "The thing that worries me is that we have never had a full-scale test of the missile systems . . . we think it's going to work . . . but I'm not sure. We have never tested an attack against those missiles so we don't know what weapons effects are going to be on these silos . . . there are a lot of unknowns. This bothers me."

Air Force Systems Command chief Gen. Bernard Schriever testified: "There are always unknown factors. We have never experienced in the world a really massive nuclear attack. The disruption that would occur . . . is very difficult to predict. We feel, at least as far as the missile hardware is concerned, it can survive an attack and actually be fired in anger. We have a high confidence. We cannot say with 100% certainty. . . . I cannot say with 100% certainty today that we will be able to penetrate defenses in 1975. I believe we will . . . but there are uncertainties connected with it."

In the Senate last week, the Defense authorization bill reported out by the Armed Services Committee added $167.9 million to the DOD request for *Nike-X* for FY '67. The funds were directed at pre-production activities the committee said could save a year in the time required between a deployment decision and attainment of the first operational capability.

In its report the committee said "it is not attempting to define the ultimate type or scope of ballistic missile defense deployment and it is not necessary to make such a determination now. The committee considers the cost of buying a saving of about one year in such a deployment as being reasonably priced insurance when one considers the consequences of being attacked without any protection. The committee understands that the Joint Chiefs of Staff are unanimous in supporting the funding of pre-production activities this year."

Nike-X misunderstanding?—The Committee's report also focuses attention, inadvertently, on what could become a major problem in reaching a decision regarding this country's overall missile defense posture, namely confusion over versions of *Nike-X*.

The report cites recent statements of Secretary McNamara (M/R, Jan. 31, p. 10) that the so-called light attack version of *Nike-X*, one that would be deployed against a relatively unsophisticated threat, small in numbers, such as could be mounted by the Chinese possibly in 1975, as one which offers considerable promise and effectiveness. Such a system could be deployed for an estimated $8-10.5 billion spread over five years and including R&D.

There is considerable attention focused on such a system (M/R, April 11, p. 13). High-level officials earlier this month told M/R that such a system is definitely in the cards, with the question still basically one of timing.

Modular approach—The report goes on to say that "because of its building-block or modular-design concept, *Nike-X* lends itself to the initial deployment of a light defense . . . and a later addition of more extensive coverage."

This statement accurately reflects a prepared statement presented by McNamara in January to a House Armed Services subcommittee.

At that time, discussing the potential for the light attack version, the Secretary said: "once fully deployed this could be augmented to increase its effectiveness against larger or more sophisticated threats—by adding more long-range interceptor missiles, by improving, radars, or by increasing the number of cities with terminal defenses."

However, very-high-ranking U.S. officials late in January said that an ABM deployed against what is called an unsophisticated threat would probably *not* be a building block of a system that would be deployed against a sophisticated threat.

The officials explained that these systems are still evolving and that it is perhaps still too early to say finally that this is true. But they did describe what is needed to defend against the two threats. One involves a thin defense spread over the entire nation to guard against any selection of targets that have been chosen for the small number of weapons involved. A heavy attack against large urban centers and other valuable targets requires a concentrated defense.

McNamara Answers Bomber Critics

WASHINGTON—Defense Secretary McNamara, becoming embroiled with increasing frequency in Congressional cross fire, left the foreign relations front long enough last week to resume defense of his military decisions.

Specifically, the Secretary answered strong criticism from a Congressional subcommittee investigating the U.S. manned bomber posture, and deferred his reponse to Joint Atomic Energy Committee criticism of his handling of new nuclear surface ship requests.

The JCAE report, which rapped DOD "cost-effectiveness' studies as dangerously based on false assumptions, recommended that Congress change the FY '67 authorization to require that the two new guided-missile destroyers requested be nuclear powered rather than conventionally driven. The Senate authorization bill offered a different solution but with the same objective. It added $4.9 million to the Navy's shipbuilding request to build one nuclear-powered guided-missile frigate instead of the two conventionally powered destroyers.

The House subcommittee, headed by F. Edward Hebert (D.-La.), focused principally upon the question of a follow-on strategic bomber beyond the FB-111.

The report questioned the Secretary's refusal to include an additional $11.8 million in the budget recommended by the Joint Chiefs to allow a start on full-scale development. The Secretary's request is for $11 million for more component and subsystem development.

The main thrust of the committee's report, however, was not limited to the FY '67 add-on, but to the stated feeling that the Secretary had indeed already made up his mind in opposition to the advanced manned strategic aircraft (AMSA).

"AMSA will always be a step away," the report stated, "Always held out as a hope and a promise but with little possibility of becoming a fact. SAC will be kept on its tippy-toes, but it won't be kissed."

McNamara, flanked at a hastily called press conference to rebut many of the committee's allegations, by Air Force Secretary Harold Brown, Gen. Earle Wheeler, Chairman of the Joint Chiefs, and Deputy Secretary Cyrus Vance, stated that he still saw "no clear need for a new strategic bomber. I want to make it perfectly clear that I have not decided against it, but I certainly have not decided in favor of it."

Testifying before the committee as in favor of AMSA development and deployment were Air Force Chief of Staff Gen. John P. McConnell, who was not invited to sit in at the press conference table, AFSC Commander Gen. Bernard Schriever, SAC Commander Gen. John Ryan, and AF RDT&E Chief Lt. Gen. James Ferguson. Also in favor of a follow-on aircraft are Air Force Secretary Brown and DDR&E Director Dr. John S. Foster, Jr.

Both Brown and Foster, however, state that the design the aircraft should take and its mission are still largely unsettled. Brown said three basic alternatives are still under consideration.

The result of this difference, the officials explained, means that these two systems will probably evolve in different forms and therefore the system deployed against the "Nth country" threat would probably not be a building block of a system designed to counter the large sophisticated threat.

Confusion results—The two statements, one on the record by the Secretary and the other attributed only to high U.S. officials, have prompted apparent confusion among lawmakers and the public.

The Secretary has stated clearly his view that any defense directed against the Soviet ICBM threat would have to be considered within the total context of damage limitation (including fallout shelters, new bomber defenses, and other elements); that any system deployed could not reduce U.S. fatalties below 50 million persons; and that the variety of postures possible would range in price between $20-30 billion. The sum of this has resulted in his continuing decision against signalling deployment for *Nike-X* against the Soviets.

Congressional observers do not believe money added by the Senate Armed Services Committee will alter this view and note several instances in the past in which DOD has refused to spend additional funds voted by Congress.

Given the much stronger possibility that a light attack version of *Nike-X* may well move into operation, Pentagon observers believe a clarification is required to determine whether or not the two versions of *Nike-X* are indeed separate or whether the light attack version does have the capability of being the first step toward the system needed to provide some protection against a Soviet threat.

In rebuttal to McNamara's charges of a "shockingly distorted" report put out by Hebert's committee, the Louisiana Congressman late last week issued a challenge to the Secretary of Defense.

At his press conference, McNamara said that when he used the phrase "we see no clear need for a new strategic bomber" in his earlier testimony to the committee, the "we" referred to the Chief of Staff of the Army, Chief of Naval Operations, Commandant of the Marine Corps, Chairman of the Joint Chiefs, the Deputy Secretary of Defense, and the President.

Hebert said that "that impression is not only misleading but completely untrue. The American public has the right to know what recommendations have now been made by the Joint Chiefs of Staff on this vital issue—let him therefore resolve it by releasing to the American public the precise language used by the Chiefs in expressing their current position on this controversial question." ■

NASA Plans Powered Flight Of Lifting Bodies in 1967

Washington—NASA has revealed that it plans powered flights of lifting-body spacecraft following the series of glide tests on the M2-F2 vehicle which is expected to begin this month.

The powered flights would be made in about a year, using an engine with a thrust of 8,000 lbs. While plans are being made for the flights, the project has not been approved by NASA headquarters.

Glide flights of the 3,000-lb. spacecraft will begin this month. It will be launched from the wing of a B-52 bomber aircraft at 45,000-ft. altitude at a speed of about 450 mph.

The possibility of powered flights has been provided for in advance space agency planning.

NASA's design of the spacecraft—which was built by the Northrop Corp.—includes a provision for installation of an XLR-11 rocket engine. If done, this would extend the flight research program to altitudes of 80,000 ft. and re-entry speeds of just under twice the speed of sound.

Northrop also built the HL-10 lifting body vehicle which will begin flight tests in mid-1966.

Flight plan—On the first free flight of the M2-F2, the B-52 will make a 20-minute circular climb to 45,000 ft. As it approaches the launch area, Pilot Milton O. Thompson will perform prelaunch checks including test bursts of the four small rockets that can be used in final approach to help cushion the landing.

The spacecraft will be launched in a straight-ahead glide and then turn left 90 degrees. This will be followed by a straight leg during which Thompson will make a practice landing flareout at about 25,000 ft.

He will then make another 90-degree left turn to the final approach. As he reaches approximately 1,200-ft. altitude, he will begin the flare maneuver to slow his rate of descent from 250 ft. per second to less than 10 ft. per second.

During this maneuver he will decrease his horizontal velocity from 350 mph during the descent to about 170 mph at touchdown.

After the flare maneuver is completed and the steep rate of descent is slowed, Thompson will extend the landing gear. If needed, four hydrogen-peroxide rockets, mounted in the rear of the vehicle, can be used to provide up to 1,600 lbs. of thrust. This would be used to give the pilot additional time to make a landing.

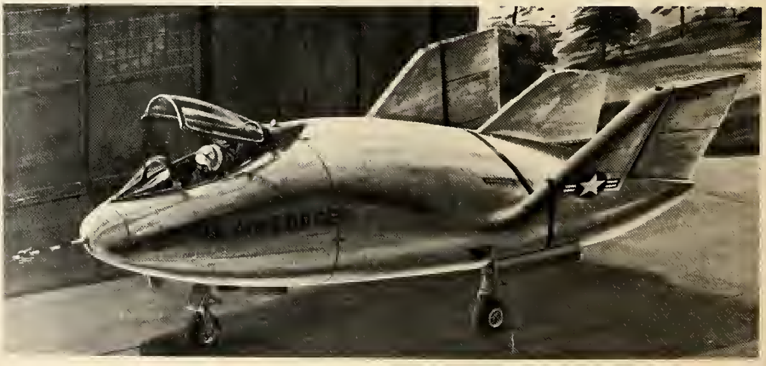
The entire flight is expected to last about four minutes.

The space agency said the purpose of the flight is to perform a complete design and systems checkout of the vehicle and evaluate vehicle stability and control. Wherever possible, back-up systems have been provided. In the event of possible failures, the spacecraft is equipped with a rocket-powered ejection seat that is designed to separate the pilot from the vehicle at any speed or altitude, even when attached to the B-52.

M2-F2 is a heavier version of the plywood M2 lifting body that was first flown in August, 1963. ■

First Look at Martin's SV-5P Design

Artists's concept of SV-5P manned lifting body vehicle which Martin Co. has been selected to build for the Air Force (M/R, April 18, p. 10). Craft will be flown under PILOT (Piloted LOwspeed Test) project, part of START (Spacecraft Technology and Advanced Re-entry Test) program. Dropped from B-52, vehicle will rocket to Mach 2 speed before slowing and landing at Edwards AFB, Calif.



Senate Group Urges DOD Fund Increase

WASHINGTON—The Senate Armed Services Committee has recommended additions to the Fiscal 1967 Dept. of Defense authorization bill which would bring the total to $243.1 million more than the Administration request.

The Administration asked Congress for $16,926,959,000. In action April 26, the committee recommended $17,170,059,000, of which $6,905.3 million would go for research development, test and evaluation (RDT&E) and $10,021.6 million for procurement.

In addition to a recommended increase of $167.9 million for the *Nike-X* program (see p. 12), other committee changes included:

—Addition of $55 million to maintain a production capability for the F-12 aircraft. While the Air Force apparently asked DOD for permission to enact several plans which would have moved the aircraft closer to production in FY 1967, none of these was approved. However, the committee said it considered the maintenance of the production option of sufficient importance to justify the expenditure of the $60 million required in the fiscal year, $55 million of which it added, with the remainder to come from the Air Force RDT&E budget.

—Addition of $4.9 million to make up the difference in transferring funds from a plan to construct two conventionally powered guided missile destroyers to construction of one nuclear-powered guided missile frigate.

—Addition of $19.9 million for a larger number of light observation helicopters than initially planned, as per a request from Secretary of Defense Robert S. McNamara after the authorization request had gone to Congress.

RDT&E—The bill provides $843.4 million for military astronautics, including $13.2 million for the Army effort in ground communications equipment for the defense communications satellite program, and in tactical command and control communications via satellite.

The Air Force's $814.1 million in this category is earmarked for the *Manned Orbiting Laboratory*, the *Titan III* space booster, the defense communications satellite, improvements to Spacetrack, study of biological effects of spaceflight on man, space propulsion technology, and design of future flight vehicles for operations inside and outside the atmosphere.

It includes payments to the Aerospace Corp. for scientific and engineering support and the expense of operating the Arnold Engineering Development Center.

The Navy's $12.6 million is to be used for exploratory development of astronautic systems and for shipboard terminals for the defense communications satellite.

The defense agencies' $3.5 million is for work on the Defense Satellite Communications System integration into the Defense Communication System.

Missile RDT&E—*Nike-X* is the largest item in the Army's RDT&E budget for missiles, amounting to $431.4 million of the total. As part of its total funding increase for *Nike-X*, the committee added $14.4 million to the R&D portion and the remainder to procurement. Total Army missile RDT&E is $733.1 million, including significant funding for the *Lance, Chaparral*/guns, and *SAM-D*. Provision for Kwajalein Testing Site is included.

The Navy's missile development program of $665.4 million centers mostly on *Poseidon*, which totals $294 million in FY 1967. Others in the total include funds for installing *Phoenix* on the FB-111, *Condor*, continued development and improvement of the *Tartar, Terrier* and *Talos*, and a point defense surface missile system to protect small combatant ships, amphibious ships and auxiliaries from air attack.

Air Force programs totaling $830.5 million include *Minuteman II*, rocket propulsion efforts, advanced ICBM technology, *Maverick*, guidance system work, and *ABRES*, the program for development of advanced ballistic re-entry systems. Eastern and Western Test Range funds also are included.

The defense agencies are authorized $119 million for Defender, carried out by the Advanced Research Projects Agency.

Military sciences funding amounts to $161.5 million for the Army, $191.7 million for the Navy, $164.4 million for the Air Force, and $107.3 million for DOD agencies.

Aircraft RDT&E totals $1,027.8 million; ships, $282.2 million; ordnance vehicles, $367.4 million; other equipment, $847.9 million, and program management and support, $452.6 million.

Procurement—Army missile procurement totaling $510 million is authorized in the bill, including the *Nike-X* preproduction activities ($153.5 million), *Chaparral, Redeye, Shillelagh, Lance* and modifications and spare parts for these systems.

Navy missile procurement, for which $367.7 million is provided, is to go to the *Polaris A-3, Sidewinder 1-C, Shrike, Standard Missile, Talos, Subroc* and *Dash*, as well as modifications and spare and repair parts.

The Air Force's authorization of $1,189.5 million is largely to go to the *Minuteman II*, but also includes *Titan II* subsystems, *Bullpup B, Shrike, Sparrow*, and *Falcon* trainer.

Other procurment funds include Army aircraft, $612.4 million; Navy aircraft, $1,422.2 million; Air Force aircraft, $4,016.3 million; naval vessels, $1,756.2 million; and tracked combat vehicles, $362.2 million. ■

Gemini Crewmen May 'Rope' Agena

HOUSTON—*Gemini* astronauts may lasso an *Agena* target with a 100-ft. cable and set the tethered vehicles into slow rotation to demonstrate a station-keeping technique for in-orbit repair of satellites.

The plan, if approved, would be implemented on one of the remaining *Gemini* missions.

Its purpose, according to *Gemini* program manager Charles W. Mathews, would be to demonstrate hooking up to a satellite having no docking provisions and staying with it through lengthy repair—even crew sleep periods—without expending fuel. "Our thinking is to put the two vehicles into a slow spin and to let centrifugal force keep them apart."

Fueled, the *Agena* nearly matches *Gemini's* mass, and the center of rotation would be somewhere midway along the cable, depending on propellant remaining in *Agena* tanks, he said. An empty target vehicle would be considerably "lighter" in orbit (by about 3,500 lbs.) and the center of rotation would be closer to the spacecraft.

Gemini pilots would set up rotation by firing lateral thrusters in combination with either forward or aft translational thrusters to keep the line taut, he explained. The (plastic) cable would have a low force "break link" to snap and release the vehicles if the rotation imposed more than a 50-lb. pull force on the cable.

Additional details were pending approval of the plan, he said.

NASA Drops Mariner Support Plans

by Hal Taylor

WASHINGTON—NASA has scrapped consideration of a systems support contractor for the *Mariner* 1969 Mars spacecraft project and instead will issue requests for proposals for development of about 12 major subsystems.

The decision by Homer E. Newell, associate administrator for space sciences and applications, reverses testimony on the project presented before the House and Senate Space Committees and the belief of project officials at NASA Headquarters (M/R, Feb. 21, p. 14).

The move means that the Jet Propulsion Laboratory (JPL) will have sole responsibility for spacecraft design and development.

It was made, according to a NASA official, because JPL has done a good job managing other unmanned planetary spacecraft projects and because it has the staff and facilities to handle the total effort.

The official said that while there will be no systems support contractor, the subcontractors that are selected will play a far greater role in the design of subsystems and will share a greater proportion of the estimated total $98 million development cost than in any previous NASA planetary program.

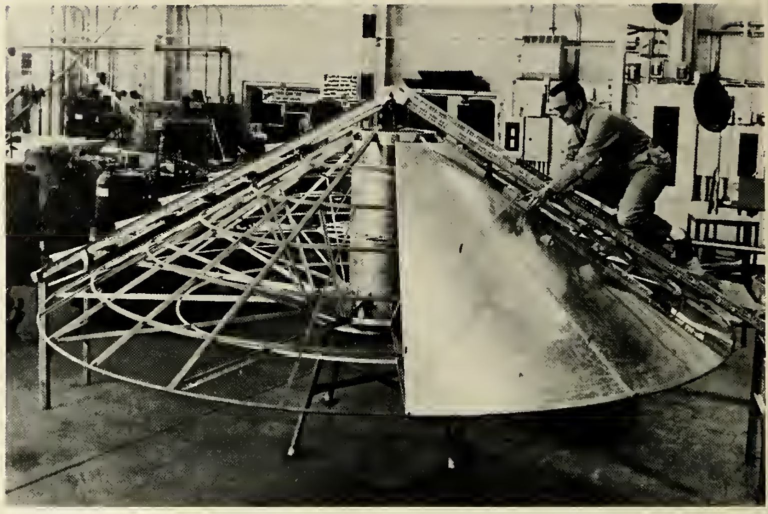
As an example, he pointed out that in the earlier *Mariner IV* project there were about 64 subcontractors sharing in spacecraft systems development. Most of the design and fabrication was performed by JPL.

The project procurement plan still has not been approved by top management. As a result, there is no definite date for the issuance of subsystem RFP's. Project officials said only that it will be "fairly soon."

Subsystem details—One major subsystem is being called engineering and mechanics. The work in the subcontract includes building the spacecraft structure, cabling, and thermal control system. This is the same hardware development which, under NASA's original plan, would have been the responsibility of the system support contractor.

Other major systems that will be subcontracted out by JPL are the guidance system, attitude control, spacecraft power system and the propulsion system.

Another is being called the science package. It includes the scientific experiments to be made as the spacecraft flies past Mars. It is expected that this will involve a separate subcontract for each experiment in the spacecraft payload. While no final decision has been made, it is believed that three experiments, including a TV camera system, will make up the science package.


Shown being constructed is a flight test unit from which parachutes will be deployed in a series of NASA experiments to check out new techniques for landing unmanned capsules on Mars. A metal skin is being placed over disc-shaped frame with a central tube that will house the packaged parachute.

Other subsystems that will be developed by industry include the communications, command system data automation, telemetry and data storage.

The JPL record—JPL had field center responsibility for development of the successful *Mariner II* exploration of Venus in 1962 and the *Mariner IV* fly-by of Mars in 1964.

Two other JPL-directed *Mariner* flights, *Mariner I* in 1962 and *Mariner III* in 1964 were unsuccessful.

JPL also directed the *Ranger* lunar hard-landing spacecraft project, which had six straight unsuccessful missions before transmitting back to Earth the first U.S. closeup pictures of the lunar surface by the *Ranger VII, VIII* and *IX* spacecraft.

It is also responsible for the *Surveyor* lunar soft-landing spacecraft now more than 2½ years behind schedule.

The first launch of that spacecraft is now scheduled for late May.

Consideration of a systems support contractor was first revealed in testimony by NASA officials before Congressional space committees. At that time, they said it was possible that such a contractor would be needed to aid JPL in directing the project.

Donald P. Hearth, assistant director of planetary flight programs at NASA Headquarters told the recent American Institute of Aeronautics and Astronautics "Stepping Stones to Mars" meeting that he believed there would be a systems support contractor.

Mars probe tests—In another action affecting future Mars exploration, the space agency announced that it plans a test program to study techniques for using parachutes to land instrumented unmanned probes on Mars.

Six balloon-borne flights and 10 sounding rocket flights—all from the White Sands Missile Range—will be included in the program, which will begin this summer.

The balloons and parachutes will be used to carry experimental parachute payloads to high altitudes where the thin Earth atmosphere compares with that on Mars. Then the test units of varying shapes and sizes will be accelerated to determine how well different parachutes can be deployed behind them. Parachutes of different designs and materials will be tested.

Balloon-borne experiments with a 15-ft. re-entry body will be carried to about 130,000 ft. and then accelerated to a speed of Mach 1.2 before the parachutes are deployed. Rocket-launched payloads will also achieve the same altitude and velocity.

The rocket-launched units will be smaller than the balloon units and shaped for lower drag capability. The parachutes and instrument package will be recovered following all flights for data analysis and evaluation. ■

DOD Plans Multi-Mission Satellite RFP

WASHINGTON—The Defense Department will issue a request for proposals to industry within the next few weeks for an experimental multi-purpose satellite.

The satellite will combine spaceborne ballistic missile launch detection functions with those of nuclear test detection and meteorology. It is expected to be the prototype for what will no doubt become a very large program.

Daniel J. Fink, deputy director of strategic and space systems within the Directorate of Defense Research and Engineering (DDR&E), reported last week that "we have concluded that these functions are compatible and could be married into a single, newly proposed satellite. Consequently, during the past year we have reoriented each of these programs towards such a common goal."

Fink, addressing a National Space Club audience here, said that DOD was "now planning a mutiple-purpose satellite feasibility demonstration" which it hopes "will provide some of the answers we are looking for" in this area.

The new satellite will be placed at synchronous altitude, and will require use of the *Titan III-C* launch vehicle. *Titan III-C* payload capability for this altitude is about 2,000 lbs. Funds have been included in the Fiscal Year 1967 budget for a start on the project.

DOD's intent to move ahead in this area was signaled last August by Dr. Harold Brown, at that time the director of DDR&E. Brown, during FY '66 budget testimony, reported that "the most probable approach to the multiple-mission satellite scheme will be to first design the spacecraft systems around the highest-priority mission, and then attempt to integrate other mission functions on a non-interference basis."

Statements by current DDR&E Director Dr. John S. Foster, Jr., last month (M/R, March 14, p. 9) made it clear that major improvements were in the offing for U.S. early warning satellites, and that future craft designed for this high-priority mission would no doubt carry other sensors.

Fink said that "superior sensors have now been developed for the ballistic missile launch detection role" and that "during the past year we have recognized that by incorporation of additional sensors other functions could also be performed simultaneously."

Beyond BMEWS—The ballistic missile detection system would essentially supplement and verify data derived from the ground-based BMEWS radars for Soviet ICBM's, but would, of course, allow detection during the launch phase rather than as the missile climbs over the radar horizon. It would also more effectively extend coverage beyond the northward-looking BMEWS radar, and—perhaps most importantly—would allow detection of submarine-launched ballistic missiles or missiles launched by the Chinese communists.

Fink said that atmospheric environmental data will be a natural by-product generated by the early warning sensors and that the experimental satellite would try to exploit this potential for military meteorological purposes.

Use of satellites at synchronous altitude for the weather observation role is important for the military, since it would make it possible to keep a particular area, e.g., Vietnam, under surveillance. Whether or not this data can be useful given the very high satellite altitude is still an unanswered question.

Both Fink and Foster have stated that nuclear test detectors would also become part of the satellite sensor package.

Space progress—In a discussion of other sectors of the U.S. military space program, Fink saw a variety of new projects evolving.

The DOD official reported that experience gained with operational navigation and geodetic satellites was such that "we are now approaching the time when we may be able to publish a satellite ephemeral almanac."

This would allow, according to Fink, a simpler navigation satellite to be used due to reduced requirements for a large ephemeral-memory subsystem. It would also permit simpler ground and shipboard equipments, he said.

Fink believes satellite navigation will also be extended to tactical warfare applications, allowing a common coordinate system to be used between all combat elements and avoiding the tendency to compound errors between units.

"Also, for the first time," Fink said, "we can seriously consider the employment of long-range tactical bombardment missiles for close support of troops" (M/R, Oct. 18, p. 18; Mar. 7, p. 12). Fink said the key to this role would be to use the satellite for determining a relative position as opposed to the more accurate position fix needed for strategic missiles.

For communications satellites, Fink sees future advanced and tactical systems with design goals of 10-year orbital lifetimes.

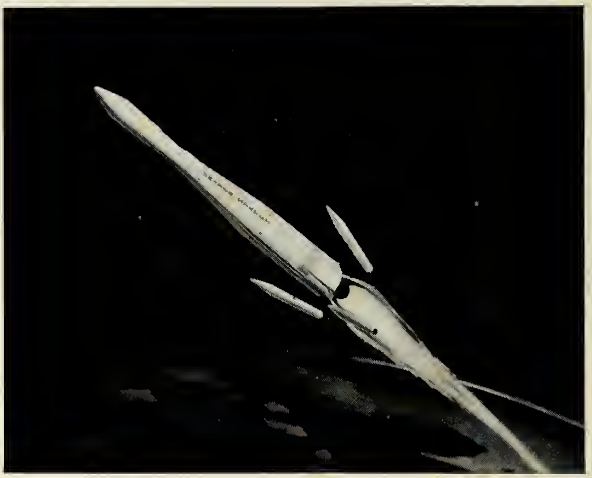
While new military comsat systems would be able to replace "very many overlapping communications systems at a reasonable cost, with easier use, and greater reliability," Fink also cautions of new problems. For example, he feels that satellite communications "will blur" the distinction between strategic and tactical communications and will require much more coordination in hardware between the services than has previously been attempted (M/R, Jan. 31, p. 34).

Autonomy backed—Fink also strongly defended the DOD concept of assigning, on a case-by-case basis, the responsibility for space systems development to the operationally oriented groups concerned with use of the information, rather than under any one office or so-called "space czar."

Though the space technology office within DDR&E provides a major focal point for technical assistance and liaison with other agencies, Fink stressed the belief that "placing the responsibility for operational development in the system office whose responsibility it is to insure that we maintain a strong defensive position is sound. Furthermore, creating a large, specialized group of 'spaceniks' would only isolate the operationally oriented types from understanding the potential that space-based systems can offer in performing their mission."

Fink said he "strongly urged that both the services and industry take a hard look at existing management structures for much the same reasons. There is a need to re-examine management in recognition that the end product we are interested in buying is not an R&D curiosity, but a military capability where most of the hardware most probably remains on the ground in the hands of a 19-year-old high-school graduate."

Tradescantia, Neurospora, Frog Eggs, Drosophila, Amoeba, Capsicum Pepper & Wheat



Biosatellite has quite a "crew" lined up for its several round-trips into space. And it's full of life.

Present orbital flights, planned for NASA, will operate from 3 to 30 days. The first will subject various biological specimens to radiation. Then rats, chiang liver cells and Arabidopsis go into space to test the effects of weightlessness on biological rhythm. Flights of 30 days duration will also orbit with an anthropoid (Macacus Nemestrina) and a complete life support system on board.

These living and scientific payloads are but a small part of the total technical content of the re-entry business. We're working on development of advanced ballistic re-entry systems... maneuverable return-from-orbit systems for precision earth landings ... flight vehicles for entry into Mars' and Venus' atmospheres... multi-place ferries and space station taxis ... plans that reach two decades ahead.

In short, the re-entry battle is just beginning, and it's an opportune time to join us. For further information about openings in SYSTEMS ANALYSIS ☐ SYSTEMS SIMULATION ☐ GUIDANCE & CONTROL ANALYSIS ☐ EXPERIMENTAL MEASUREMENTS ☐ MATERIALS DEVELOPMENT ☐ STRUCTURAL MECHANICS ☐ RADAR DISCRIMINATION ☐ PRODUCT SAFETY ☐ ELECTRO-CHEMISTRY ☐ NUCLEAR EFFECTS, write to Mr. Dan Nauer, Re-entry Systems Department, Section 394E-1 General Electric Company, 3198 Chestnut St., Philadelphia, Pa. An Equal Opportunity Employer.

RE-ENTRY SYSTEMS DEPARTMENT
MISSILE & SPACE DIVISION
GENERAL ELECTRIC

ELECTRONICS

Boeing Guidance Simulator in Use

An electro-optical guidance simulator, now in use at Boeing Co.'s Kent, Wash., Space Center, employs both theatrical and aerodynamic inputs for target-tracking mission problems. In its present configuration, a gimballed mirror, a precision zoom lens, and projection screen are used with a three-axis stable flight table. Readout is through a SDS-930 digital computer. The tracker under test is installed on the flight table and directed toward the rear-projection screen providing the strike scene. The zoom lens provides accurately programmed closure with a 50:1 zoom ratio. At completion of the run, the computer reads out homing-device target-image distance from actual target center. During a given test run, a variety of external influences can be programmed into the computer, including local atmospherics, foliage and even anti-missile defense measures from the target or target support, Boeing said. Facility cost to date is $250,000, but more will be invested to expand simulations from optical and area-correlation only to radiation and laser-spot homing.

Radar Film Processor Under Design

An advanced optical correlator for processing radar data film will be designed and built by Goodyear Aerospace Corp.'s Litchfield Park, Ariz., facility. The $750,000 unit is funded by the Army Engineer Geodesy, Intelligence and Mapping Research and Development Agency. The device will be able to handle all filmed data collected by coherent radar systems. The contract includes training of personnel to use the advanced optical correlator. Goodyear Aerospace also manufactures both optical and electronic correlators to process the radar film obtained by their side-looking system.

LIFE SUPPORT

Synthesized Food Sought

Two biochemists at the University of Miami are trying to get at the core of space feeding problems under a NASA grant. Ultimate objective of the project is a means to provide the necessary amino acids to astronauts in the exact relative proportions in which they are needed. The scientists are producing synthetic polyamino acid molecules and are seeking to determine the nutritional requirements for these protein substances in white rats. Later tests will be made with human beings. Studies are also planned to determine the most efficient manner of supplying these needs in a spaceship. Weight of protein carried could be cut considerably, the scientists say.

Half-Safe Is Still All Right

The effects of minimal personal hygiene and other conditions which might arise in a long-duration spacecraft without the toilet comforts of home have been evaluated in nine 6-week experiments at the Air Force Aerospace Medical Research Laboratories by 36 subjects. Lack of bathing and changing clothes was found to cause no major problem, although body odors heightened after seven to ten days in the simulator. Response to these odors subsided in the second week, Air Force scientists report. Dental health caused the greatest problem, with all subjects developing some effects of substandard care. Half the subjects needed to cut their nails after four weeks, and one-quarter found it necessary to trim their mustaches because of lip irritation. Much dryness of skin and scalp occurred, along with some irritation from continued wearing of electrodes.

PROPULSION

Thiokol Fires High-Energy Motor

A 52-in.-dia. advanced upper-stage glass-wound solid motor will now be used to test thrust vector control concepts after a successful test firing at Thiokol Chemical Corp.'s Wasatch Div. The firing demonstrated the effectiveness of the high-performance case and the integrity of a high web fraction grain with a high-energy propellant. The Class 2 composite solid propellant was fired through a submerged, fixed nozzle. The in-house program is aimed at a prototype upper stage unit such as the improved Stage III motor for the *Minuteman.*

Hercules Builds Poseidon Eject Motors

Small, controlled-burning-rate, solid motors designed to generate steam for the submarine launching of the *Poseidon* fleet ballistic missile will be designed and built by Hercules Powder Co.'s Allegany Ballistics Lab. The system will be similar to that currently used in the *Polaris* program. Total value of the contract from Westinghouse Electric Corp. over the four-year development period will be $9 million. The solid motor exhausts through a water chamber, changing the liquid to steam, which is then metered to the launch tube to push the missile out of the sub. The motor provides an increasing volume of exhaust to keep pace with the volume created as the missile moves up the tube.

MATERIALS

GE Al-Coloring System Goes Commercial

The Schmidt process developed at General Electric's reentry systems department for permanently laying color on the surface of aluminum and some other metals will be reduced to a commercial process by Sel-Rex Corp. The color process has been used by GE for temperature control in small satellites. Sel-Rex markets precious metal compounds and chemicals for use in electro-plating; most of the end-products are in electronics, communications and space. The Schmidt coloring process may evolve into a coating for a significant percentage of the eight billion pounds of aluminum produced annually in the U.S.

EXOBIOLOGY

Venus Life Suggested

Two Johns Hopkins University astrophysicists have reiterated their belief that temperatures on the surface of Venus may actually range between 340° and 580°F at the equator, and that extensive regions comfortable for man may exist elsewhere on the planet. Based upon the study of the infrared spectrum of Venus with the help of high-altitude balloons, the scientists suggest that Venus may be capable of supporting life as it is known on Earth. Measurements made by radio astronomers at the California Institute of Technology also indicate that part of the microwave radiation—on which the high temperatures were based—may not wholly originate from the surface but from electrical discharges within the Venusian atmosphere.

LMSC Sees Varied Role for Deep Quest

SUNNYVALE, CALIF.—Lockheed Missiles & Space Co. officials expect their small research submersible—Deep Quest—to be used as a test bed and training vehicle for development of the Navy's prototype Deep-Submergence Rescue Vehicle (DSRV)—as well as for what the company feels will be an ever-expanding list of military and commercial undersea programs. (Lockheed was recently selected by the Navy to develop the prototype DSRV [M/R, April 18, p. 12].)

"We see Deep Quest as complementing the Deep Submergence Systems Project," J. G. Wenzel, manager of ocean systems and deep submergence programs, told MISSILES AND ROCKETS. "It can serve as a test bed for components such as sensors, advanced instrumentation and communications techniques. It can also be use as a training vehicle for the DSRV to train the crews which will operate the rescue vehicle and as an aid in the design of the rescue vehicle.

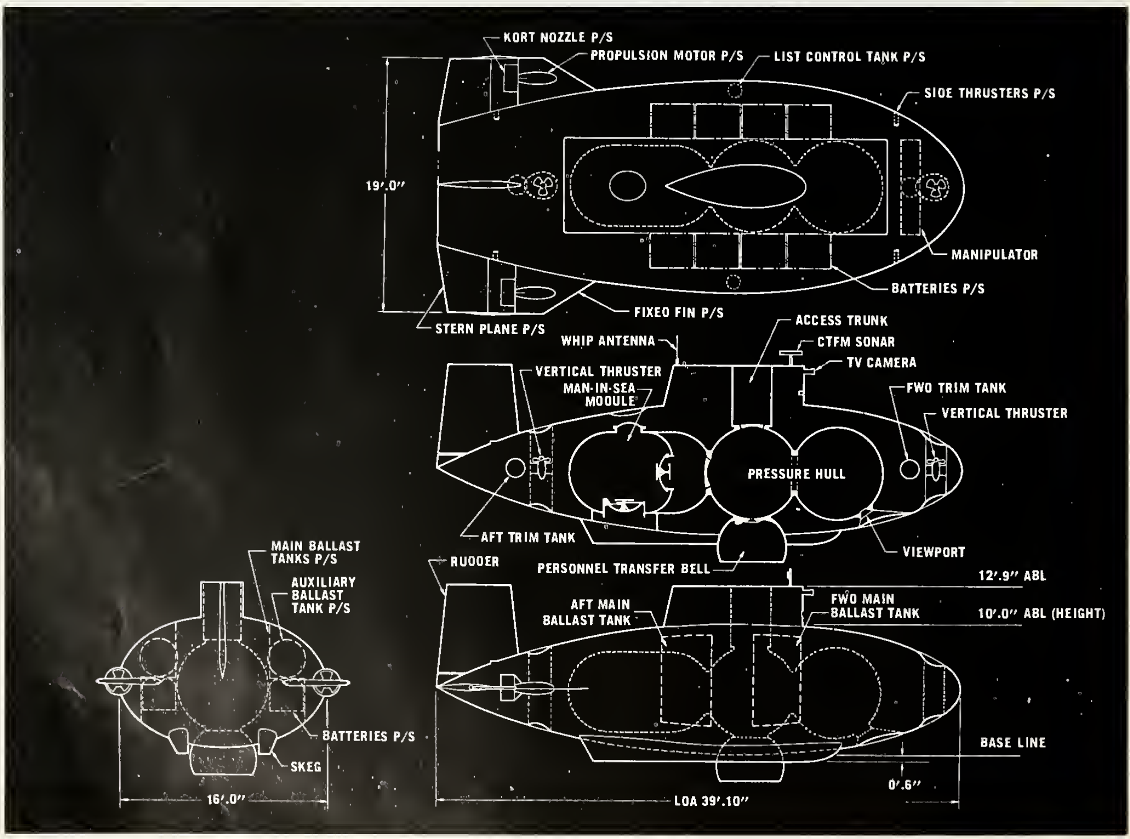
"Although we are looking forward to using Deep Quest as a demonstration and training vehicle," Wenzel stresses, "we have no assurance that the Navy will buy our proposal."

Deep Quest is being fabricated at LMSC's plant here and is expected to be ready to go into the water at Lockheed's San Diego Marine Laboratory by late October or early November. Following three months of testing, the vehicle is to be operational by early 1967. This is some 9 to 12 months ahead of the DSRV, Wenzel estimates, and thus Deep Quest could be of value in the Navy program.

Missions will grow—While the role of the LMSC submersible in the Navy rescue vehicle program is still speculative, the company has joined with International Minerals and Chemical Corp. of Skokie, Ill., and the Dept. of Interior's Bureau of Mines in a joint program of deep-sea mining research. Although formally under contract to the bureau, the two companies are contributing their own funds to the project.

Basically, the objectives of the program are to develop methods of exploration of the ocean bottom for mineral deposits and to develop the tools (such as corers) to collect samples. Deep Quest, in its modular payload compartment, can be outfitted to take cores up to 8 ft. from the ocean bottom and can also collect and store individual samples. The

Drawings show dimensions of Lockheed's Deep Quest. Craft displaces 50 long tons and payload module weighs 7,000 lbs.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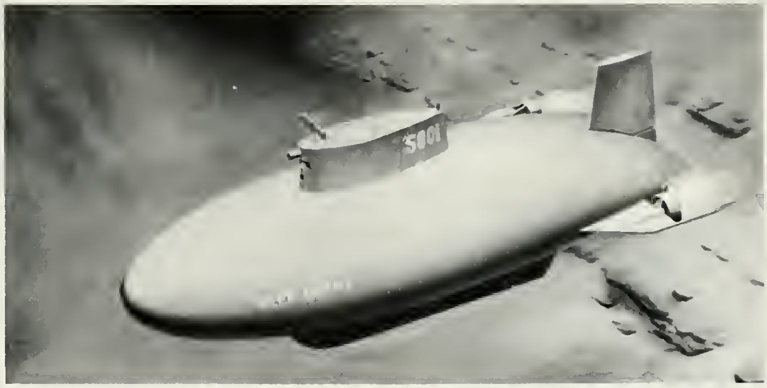

Artist's concept of Deep Quest hovering at ocean bottom on exploration mission.

Navy will release two ships to work on the project.

By changing the modular payload compartment, the vehicle can be used for man-in-sea diver support to depths of 1,000 ft. Two divers, completely separated from the bi-spherical, two-man crew compartment, have complete freedom of egress from a hatch in the botom of the vehicle.

For oceanographic research and exploration, Deep Quest provides a high payload. Up to 7,000 lbs. can be carried in the 700-cu. ft. "wet" payload module. An additional 30 cu. ft. of mission-oriented equipment can be carried within the pressure hull.

Other missions which Wenzel foresees for the small submersible include: search and rescue, recovery of aerospace objects, cable inspection and repair, underwater maintenance and support, marine archeology, undersea construction and salvage. Not all of these, of course, will be done by the Deep Quest, but Wenzel feels that as "we get into the program additional missions will become evident." The real expansion of the Deep Submergence Program, he feels, will take place in 1969-71, "when we will have a lot of technology in the bank and we will be able to explore and exploit the potential of the oceans."

An important step—Of the small, maneuverable submersibles, Deep Quest is outstripped, in terms of duration, only by the Reynolds Aluminaut. The LMSC vehicle has an endurance of 24 hours at two knots and 12 hours at four knots; the Aluminaut has a 32-hour stay time at three knots. While the prototype DSRV is expected to operate only down to 3,500 ft., the operational rescue vehicle will reach 6,000 ft.—the operating depth of Deep Quest. Collapse depth for the Lockheed vehicle is 12,000 ft.

The ellipsoidal outer hull of the vehicle is made of 5083 aluminum, while the intersecting spheres of the pressure hull are of 200,000 psi maraging steel. Fabricated by Sun Shipbuilding in Chester, Pa., the bi-spherical pressure vessel is one of the big steps forward in the Deep Quest program. "We have proven the principle of intersecting pressure vessels," Wenzel says. The problem, he points out, is that the pressure everywhere across the joint must be the same as that on the walls of the spheres. In other words, the pressure differential across the joint must be zero. To achieve this took an enormous amount of analysis before a solution was found. However, the resultant bi-spherical pressure vessel gives the 3-4 man crew more volume per man—an important consideration for missions of 24 hours or more.

A design consideration—In attempting to strike a balance between a high payload and a hydrodynamically efficient hull, LSMC engineers examined a wide range of pressure vessels—ranging from cylinders to spheres and toroids—before settling on the bi-spherical hull on the basis of its greater usable volume, better habitability and lighter total system weight. Distinguishing between "free volume" (space not occupied by instrumentation and other internal hardware and therefore actually available for crew occupancy) and "total volume," LMSC engineers determined that an allotment of 50-60 cu. ft. of volume per man was reasonable for crew habitability for a long-endurance, deep-submergence vehicle.

The bi-spherical Deep Quest provides 64.1 cu. ft. per man for a four-man crew and 85.4 cu. ft. for a three-man crew. (For comparison, *Mercury* spacecraft provided 48 cu. ft. for the astronaut, *Gemini*, 53 cu. ft. and *Apollo*, 75 cu. ft.)

Vehicle characteristics—Overall length of Deep Quest is 39 ft. 10 in.; beam is 16 ft. and maximum width 19 ft. Two 7½-hp a-c motors mounted on the horizontal stern planes, one on either side of the outer hull, provide forward thrust; similar motors mounted fore and aft of the pressure hull and payload module provide for vertical displacement. Lateral displacement is furnished by water-jet thrusters. Maximum speed of the Deep Quest is 4.5 knots and it has a hovering capability in a 0.5-knot current.

In addition to the externally mounted television camera and sonar, the vehicle is equipped with manipulators which are operated remotely from within the pressure hull. A view port in the bottom of the vehicle permits visual observation of the ocean bottom.

Electrical power for the vehicle is furnished by batteries. These are the limiting factor on the duration of operations, since the life-support equipment is designed for 48 hours. LMSC officials feel that fuel cells eventually will replace the batteries.

Lockheed gamble pays off—When Lockheed announced in April, 1965, that it would build Deep Quest and that the project would be company-funded. LMSC had only the Bureau of Mines contract in hand. Therefore, the submersible was a gamble. Companies studies, experience in deep submarine technology for the *Polaris* program and its work on space life-support systems (similar in many ways to keeping men alive in the ocean environment) gave the company a reservoir of technical talent for the project. However, there was no assurance that once the vehicle was built the military would use it.

How much the company spent, and is spending, on Deep Quest is a subject which it will not discuss, but the impact which the vehicle had on LMSC's DSRV proposal has more than justified the gamble. Nevertheless, in building the Deep Quest, LMSC "tried to select those (design) areas which will also have application to commercial ocean exploration" as a hedge against the possibility that the military would find little or no use for the vehicle after it was developed.

"The real business potential for exploitation of the deep sea environment," Wenzel feels, "is in the post-1970 time period. In the next five years, the emphasis will be on very aggressively developing the technology to exploit this potential." Deep Quest and the DSRV will put Lockheed in a strong position to develop the technology to explore and exploit the ocean bottom, company officials feel.

One corporate executive told M/R that by 1970 he expects Lockheed ocean systems, both surface and sub-surface, to be contributing "about $100 million a year" to the firm's Government sales picture. ■

ESRO Favored for European Comsat—If

A DECISION IS IMMINENT on the make-up of Europe's communications satellite team, which is scheduled to begin work next spring. But there is some doubt whether the project will ever get off the ground.

If the comsat system is undertaken, it will very likely be a product of the European Space Research Organization (ESRO), on behalf of the Conférence Européene des Télécommunications par Satellite (CETS), with launch vehicles provided by the European Launcher Development Organization (ELDO).

No formal announcement concerning a decision has been made, but results of closed-door meetings indicate this would be the final team. If it is not, finding another team willing to work together in the same organizational relationship may prove difficult.

British balk—Further uncertainty developed in Paris last week during a ministerial council meeting of ELDO. Britain, which produces the already flight-tested *Blue Streak* first stage of the three-stage ELDO booster *Europa 1* —and pays nearly 39% of the costs of the organization, reportedly believes that *Europa 1* is inadequate for launching a comsat system that would be commercially competitive with the U.S. Comsat Corp. network.

The British were said to be pressing for development of a more powerful *Europa 2* booster—and to be considering pulling out of the joint effort if their views do not carry. Should Britain drop out, the other ELDO members would be forced to develop a new first stage, or attempt to buy one from the U.S.

The situation regarding the make-up of the projected comsat team has been unsettled while CETS, the user agency, evaluated the relative advantages of naming either ESRO or ELDO as manager of the development program.

The alternatives of either creating another new European organization to handle the program or of creating a joint management committee composed of ESRO and ELDO experts were rejected in favor of a clear-cut decision favoring one or the other body.

With the advantages of being named program manager looming large before it, ESRO is eyeing the decision anxiously.

ELDO, pointing out that its charter is flexible enough to permit its handling programs other than launcher development, feels it would be able to spread the work over a large geographical area, rather than in a central laboratory. In spite of this, ELDO seems to foresee its role as that of a subcontractor.

ESRO favored—With the possibility of one hitch, ESRO seems a clear choice for the prime manager's assignment. The one hitch is that concern is being voiced by European scientists over effects possibly detrimental to the scientific space research program in Europe if the commercial communication satellite program is handled by ESRO. If this worry can be eliminated, as ESRO feels it can be, there would be no remaining barrier to ESRO's selection.

Decision on which of the two organizations will get the job rests solely with CETS, and the final relationship would resemble that in the U.S. between NASA and the Environmental Science Services Administration.

Final report by the CETS secretariat is expected soon and has been in the making since mid-February, when the three agencies met in London. The expected decision would put ELDO in the program as a supplier of launch vehicles and ancillary equipment, rather than as program manager.

Although ELDO seems willing to accept this role, ESRO appears quite unwilling to become the subordinate organization. Queried on its attitude if ELDO should be named overall manager with ESRO named subcontractor for the spacecraft portion, ESRO replied that it would not consider this a viable way of working. Such a comment had already been ventured by the ELDO hierarchy, ESRO pointed out. Furthermore, to place ESRO in a subcontractual position would further increase the fears of the ESRO scientists, since it would give ESRO even less control over the program.

Satellite development determinant—ESRO said the key part of the program is the communication satellite itself, and that is where the management of the program should lie.

Concerning the fears of some that the scientific work of ESRO would be disrupted if slippages occurred in the communication satellite program and placed a heavier-than-expected demand on finances and facilities, the ESRO representative said it might be impossible to guarantee the sanctity of the scientific work if this should happen. Further question by the CETS representatives at the meeting brought out fears of what would happen to the ESRO image when the commercial aspects of the communication satellite were felt following completion of the development phase.

In discussing the legal framework for the program, representatives of CETS decided that a firm and detailed agreement was required in case satellite communications work might not rate so highly with ESRO as its regular scientific work.

There has been no reluctance on the part of either ELDO or ESRO to accept the responsibility, however, and the main point of contention appears to be the nature of the interfaces—both technical as regards the launcher/payload and managerial as regards the authority and responsibility.

(There is a slight possibility that an American launcher will be used in the program, but this is not considered likely. It was suggested at the London meeting that U.S. officials should be asked if a launch vehicle would be available, but the suggestion was turned down on grounds such a query would be "inopportune.")

(A decision to use an American launcher would change the entire nature of the competition between ESRO and ELDO. It would probably also mean a serious reconsideration of the future of ELDO.)

Management approach—In their proposal to CETS, the ESRO officials said they would handle a communication satellite program just as they do their other projects, but keeping it totally separate in terms of staff and finances so as not to disrupt the scientific work. The approach includes a "standard" arrangement of a project team, a manager with full technical and partial financial responsibility, and a headquarters staff to plan full coordination of technical and financial aspects.

If necessary, ESRO told CETS, a components division could be established to deal with problems of basic components and reliability.

For procurement, ESRO said it would consider Europe as a single entity, with hardware contracts being placed regardless of geographic location. The organization said it could change this policy if CETS desired.

The only potential difficulty ESRO saw in its envisioned future working relationship with ELDO—assuming ESRO as prime manager—was in the differing organizational setups of the two organizations. ELDO is a coordinat-

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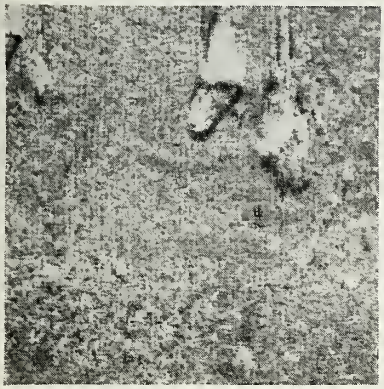
1. Downed aircraft

2. Lost drilling rig

3. Earthquake fault

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ing group in which the work is carried out by companies located in the member nations, while ESRO is working on projects in its own facilities.

ESRO is already working with ELDO on a launcher for Europe's large astronomical satellite.

If ESRO's overall management of the communications satellite project is confirmed, it is expected that actual launching and tracking of the satellites will be a joint operation of ESRO and ELDO.

(As mentioned previously (M/R, April 25, p. 43) the entire communication satellite program is being conducted on a basis of "if and when" the final details are approved by all the governments involved.)

Responsibilities—The ESRO project team, which would report to the ESRO director of projects, would have about 10 staff members by the spring of 1967. Main task of the team would be specification of the experimental communication satellite and control of contracts within industry. It is assumed all contracting for the program will be done in Europe.

The project team of 10 men would be specifically responsible for the engineering development of a prototype satellite, as well as the flight models and all testing.

Another team of about six men would be built up in the instrumentation division of the applied research department, depending on the agreed-upon arrangements with CETS. From the point of view of the project team, this second group would be responsible for establishing communications requirements and designing equipment. In practice, they would operate somewhere between the extremes of simply interpreting CETS requirements or initiating all requirements and equipment themselves. The balance between the extremes will be agreed upon after consultation with CETS.

In its proposal to CETS, the ESRO official position was spelled out as favoring a "total separation" between staff and finances on the communication satellite work and the existing ESRO scientific work. In an internal policy paper, however, the ESRO directorate commented:

"It would be necessary to recruit some personnel quickly but the final complement of the instrumentation division need not be changed if it is accepted that this work is in line with the applied research required from the instrumentation for ESRO."

Further integration of the communication satellite work into the mainstream of other ESRO activity seems inevitable, since the same policy paper indicated that the CETS work would draw on support from at least six ESRO divisions now working on scientific research.

Equipment included is normal for space technology development and testing: high-vacuum chambers, solar simulators, vibrators, centrifuge, and other facilities. Computers and other ESRO facilities located in the Netherlands and Darmstadt, Germany, are also to be placed on call.

Other ESRO support facilities would bring their telemetry and tracking equipment into the CETS program.

ESRO had previously planned to establish a materials and components division, but cancelled such plans because of lack of sufficient work to justify the move. Now, with the CETS program looming, ESRO has once again begun thinking about such a division, with CETS financing part of it. The percentage of the division's cost borne by CETS will be agreed upon by negotiation.

ESRO officials in London assured the CETS committee that the policy paper was intended only "to alleviate the fears of ESRO scientists that the CETS project might disrupt existing programs . . ." This does not have to be the case, ESRO said.

Financing—CETS asked the ELDO delegates to the meeting how the program financing details would be worked out if ELDO were given prime responsibility, and ELDO cited this as a problem typical of working with programs requiring varying levels of contributions, three organizations with differing memberships, and quite a few governments.

No hard cost figures were brought up at the meeting, and the questions of ground stations, satellite use allocations, and similar considerations were touched only lightly.

Interface problem—The question of exactly where the interface between launch vehicle and spacecraft should lie was treated at greater length in the London conferences than the question of the potential manager's facilities, capabilities or suitability for the job.

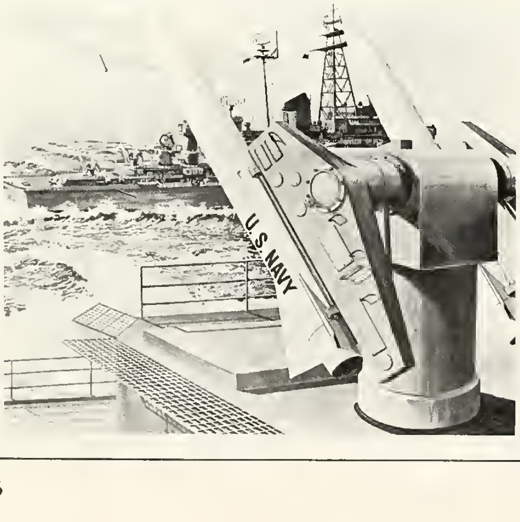
ESRO delegates expressed the view that the interface between vehicle and payload should be as simple as possible, with no propulsion units attached to the spacecraft once injection was achieved. Attitude stabilization and correction, ESRO said, should be handled as part of the spacecraft system.

ELDO, agreeing wholeheartedly with ESRO on the point that program direction should be in the hands of only one organization, pointed out that the simplest vehicle/payload interface may not be the most economical. ELDO has already conducted extensive studies of spacecraft attitude-control systems, with particular attention to the requirements of communications satellites.

In its proposal to CETS on the communication satellite program, ELDO suggested that if another organization were named program manager, ELDO should be given responsibility for the launch vehicle and the satellite stage, including injection motor, structure, stabilization and attitude-control systems, and spacecraft energy sources.

CETS asked if there were no other ways to delineate the interface, and ELDO replied that an alternative would be between the final stage of the launch vehicle and the entire satellite. The organization added, however, that greater economy from the propulsion development viewpoint would be obtained using the recommended interface. Integration of the boost propulsion and orbital propulsion systems was best, ELDO said. ■

Lance Shown Deployed Aboard Ship



Army's Lance is depicted in its seagoing role as the Navy's landing force support weapon. Developed for the Army by LTV Aerospace Corp., Lance would use modified Terrier launchers aboard ship. The Navy has requested $2 million in FY '67 to begin work on the "Sea Lance." The weapon could carry a nuclear warhead some 70 km.

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Air Force Funding GE Tests Of Possible Space 'Lifeboat'

by Heather M. David

LAS VEGAS, NEV.—A conceptual emergency space enclosure using a semi-permeable membrane as a passive life support system is being tested at General Electric's Missile and Space Div.

The work is based on the fact that the silicon rubber membrane, initially developed by GE's Research and Development Center for underwater use, allows carbon dioxide to escape at a rate of from five to five and one-half times that of pure oxygen. Water vapor also is removed, GE said.

Supported by funds from the Air Force Aerospace Medical Research Laboratories, GE scientists Edward Glanfield and David Withey of the Manned Orbiting Laboratory department have constructed a prototype extravehicular or emergency enclosure in the form of a sphere which would supply thermal protection as well as oxygen to an astronaut in space.

The sphere or cocoon, as GE scientists call it, could be used for extravehicular tasks to remove the astronauts, without spacesuits, from the main vehicle. It could also serve as a "lifeboat" to abandon the main vehicle.

While no attempt has been made to achieve optimum weight and size in the current model, Glanfield told MISSILES AND ROCKETS that he thought the cocoon itself could be reduced to a weight of about 25 lbs., the hatch being the determining factor in both weight and size. The prototype was shown at the 37th annual meeting of the Aerospace Medical Association here.

Now under way at Valley Forge Space Technology Center are permeation tests, thermal vacuum tests and similar studies to see if the membrane is affected by the vacuum.

Appearance—The 6-ft.-dia. conceptual sphere—although it could take other sizes and shapes—is designed with an observation port on one side and the hatch on the other.

Surface coating is of aluminum Mylar 2 mils thick, covering an insulating composite of 15 layers of ¼-mil aluminum mylar tied together at intervals with buttons. Velcro patches are used to hold other layers down and to secure them around the observation port.

Next is a structural layer of Dacron cloth, which covers a sandwich of Dacron paper, the silcon rubber membrane and bottom layer of Dacron paper.

The membrane cloth is the same as that being used by NASA in otolith experiments at Ames Research Center, and has kept a rodent alive underwater for some time.

In the conceptual version, the cocoon would be stored in the spacecraft folded up with a supply of stored oxygen inside. When ready for use, erection tubes running around the circumference of the sphere would be filled with high-pressure gas to give the structure some form to enable the astronaut to enter it. The oxygen supply system would then be activated.

The sphere is designed for operation at 100%-oxygen, 5-psi atmosphere. Glanfield estimated oxygen consumption at about two pounds per day per man, plus two pounds per day loss through the membrane.

Expectations—Tests indicate that the concept would be quite efficient in maintaining a fairly comfortable temperature range in orbit. Glanfield said that about 60 watts of additional heat would be required to maintain the enclosure within a range of 65-85°F in an orbit from 100 to 300 n. mi.

The 6-ft. sphere, with a membrane area of about 100 sq. ft., should be able to maintain carbon dioxide at from 8 to 12 mm Hg., or about 1%, with one astronaut inside, Glanfield said. Area would have to be increased for it to be effective with more than one man.

Since the preliminary work has dealt mostly with proving out the membrane concept, many possible refinements have not yet been explored. These might include micrometeoroid protection and other life support improvements. ■

U.S., Soviets Exchange Medical Data

LAS VEGAS, NEV.—Three differences exist in findings from Soviet and American orbital manned spaceflights, physicians from the two countries agree.

Although Soviet physician Armen Aramovich Gyurdzhian characterized the differences as very minor, NASA's Dr. Charles A. Berry noted that findings have varied between the two countries in the vestibular or inner-ear area, in red blood-cell count after the flight, and in measurements of the delay between the electrical signal and heart action.

A point of considerable significance to the U.S. space program is the fact that the Soviets have had no decrease in red blood-cell count.

U.S. astronauts have had such a decrease, which radioisotope tagging indicated was a destruction of red blood cells in the spleen at an earlier time than normal on Earth.

The Soviet disclosure confirmed what Berry and others have suspected —that the decreased count was due to the 100% oxygen atmosphere used in the U.S. spacecraft, rather than the weightless condition. The Russians use a sea-level, 21% oxygen-79% nitrogen atmosphere.

Heart delay—The Soviets have reported another aberration that has not been confirmed by U.S. measurements, nor explained by Soviet doctors. With the use of electrocardiograms and seismocardiograms, they have measured the interval between the normal electrical stimulation of the heart and the action it evokes.

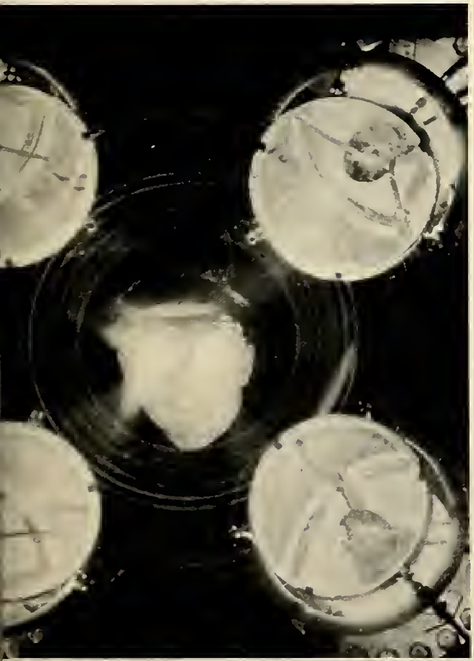
While the Soviets have reported that a delay occurs in this interval compared with Earth-bound baselines, similar studies performed on recent *Gemini* flights have failed to confirm this finding. No assessment of its effect upon the total organism has been put forth by the USSR.

The Soviets have reported that several of their cosmonauts had unfavorable reactions in their vestibular systems—centers of balance—to spaceflight. This began with Gherman Titov, who became quite nauseated for several orbits. It produced illusions of rotation in several other flyers, and forced the termination of the *Voskhod I* flight because of the discomfort of cosmonaut/physician Boris Yegorov.

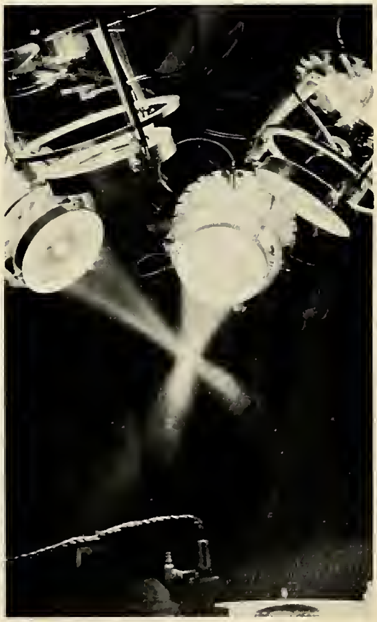
Gyurdzhian attributed the difficulties to insufficient training, saying that the Soviets and U.S. differ only in details in this area. U.S. observers have suspected that Soviet difficulties have stemmed from a high roll rate, but the Soviet doctor denied this.

No Soviet spaceship has approached the high roll rate of *GT-8*, which reached one revolution per 0.8 second, although one Soviet capsule had a tumbling rate of one revolution every 20 to 40 seconds. However, the cosmonauts' difficulties did not occur during these periods, he said, but were caused by the weightless condition itself.

Avco/RAD's ROVERS Operational



A Radiation Orbital Vehicle Re-Entry Simulator (ROVERS) is now in operation at Avco's Research and Advanced Development Div. The facility can focus 800 Btu/ft.^{2}/sec. on 12-in.-dia. samples. The four lens-coupled devices are the radiation sources and each is controlled separately as is the center arc source. Trajectory variations can be programmed into the facility as well as Earth altitudes to 150,000 ft. and other planetary atmospheres. The photo at top right shows one of the radiation elements being calibrated. The $500,000-plus facility was used without the radiation elements in acquiring design information on the Apollo re-entry shield. Correlations with the recent Apollo sub-orbital test were described as good.



Martin Missile Guidance Development Center Opening

by Charles D. LaFond

ORLANDO, FLA.—The Martin Co.'s Orlando Div. has a new $2-million-plus tactical-missile guidance-system development center that features a pilot-display laboratory, an RF anechoic chamber for radiation tests, a large optical guidance lab and a supporting computer complex.

The optical test area provides a 5-degree-of-freedom precision mount and carriage for systems under test and a 40 x 40-ft., 600:1-scale terrain model which moves along the sixth axis (closure). Covering more than 12,000 sq. ft. of floor space, the center was dedicated April 25, is now undergoing calibration testing and is expected to be operational by June.

Not content with what already is believed to be the most advanced facility available for testing air-to-surface and air-to-air weapons guidance systems, officials here are looking ahead to expanding the present broad capabilities.

Future plans include animating targets on the big terrain model to inject greater realism in "air strikes" and the development of a 3,000:1-scale terrain model. The latter device will permit overflights of up to 500-mi. range to be simulated, expanding testing to other types of systems for mapping, terrain avoidance or even long-range guidance.

Reduce flight tests—A primary goal in determining the need for such an elaborate guidance test facility, according to Martin-Orlando's John P. Butterfield, Tech Operations Director, is to reduce the long time needed in development of new guidance systems. This can be done, he stressed, and it is also possible to eliminate much of the present performance uncertainty in initial flight testing by thoroughly laboratory-testing systems on a repeatable basis prior to flight test.

In the past, however, the tools to permit such rigorous tests simply were not available.

The present emphasis by all the military services on all-weather launch-and-leave tactical air-to-surface weapon systems provides a good potential for the Martin investment.

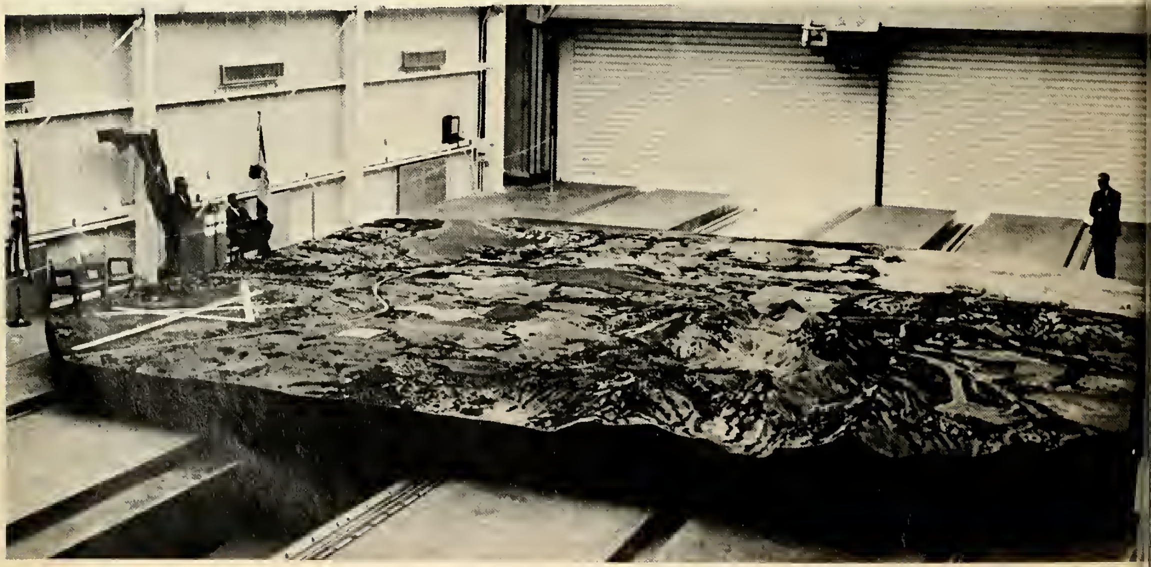
Butterfield also pointed out that i the past technology has too often passe the design capability of systems unde development because of the long R&I period required to produce a satisfactory instrument and marry it to a weapon system. The case of *Shrike,* th present anti-radiation missile, is a typical example, he said, of defensive technology advancing to a point nullifyin the effectiveness of the weapon when i reached the operational stage.

The new guidance center, Butterfield stressed, will permit exhaustiv system testing against realistic target over and over again in all dynamic extremes. No longer weather- or pilot limited or subject to intolerable dela during crucial early flight tests wher design changes may send the devic back to the laboratory, new systems developed in the center should be in th near-operational stage before they experience actual flight test, and the number of flights required for complete system integration and calibration will b minimal. Even extensive pilot trainin can be accomplished in the center prio to flight testing.

General GDC details—Overall, th center occupies some 12,000 sq. ft. o floor space. All of the labs comprisin the facility, although appearing connected to one another, are physicall isolated—foundations are all separat and roof lines between structures ar bellows-connected.

Well over a million pounds o foundation concrete were employed an the earth beneath and around the pad was stabilized by pumping into it ove 18,000 gallons of a liquid bondin agent, officials disclosed.

Interior of new development center shows 40 x 40-ft. scale model used to test new missile optical guidance systems.



Centrally air-conditioned to ± 5°F nroughout, the plant uses over 135 ons of equipment. Center power supply from a 100-kva source.

Power for the extensive lighting sys-em equals 150 kw/hr. maximum to andle 315 fluorescent lights (400 ft.-andles) and 144 incandescent lights 100 ft.-candles) in the optical guid-nce lab plus the more conventional ghts throughout.

Electro-optical lab—Two principal evices make up the electro-optical uidance test lab: the 40 x 40-ft. rail-ounted terrain model and the flight ble/carriage/beam assembly carrying e system under test.

With its 600:1 scale, the terrain odel simulates a 20-sq.-mi. area. On are located all the traditional targets ssociated with air-to-surface strikes -including bridges, a dam, seaport, ilroad marshalling yard, oil storage ea, airport and industrial complex.

Terrain varies from mountains to ains well spotted with rivers and lakes, d also includes an extensive desert.

Time of day and local atmospherics fecting light contrast are simulated by elaborate lighting system, provided ith considerable intensity and unit ntrol.

For true light conditions the terrain odel can be moved on its tracks out-oors.

Weighing some 12,000 lbs., the odel is powered by a 40-hp d-c motor ing a rack and pinion drive. Round-ay bearing rollers support the structure the precision tracks. It is capable of linear velocity of 10 ft./sec. and can so be tilted up to an angle of 25° to ry mission simulations.

The 2,700-lb. beam for the flight table and carriage (total weight 7,800 lbs.) provides a 46-ft. horizontal and 24-ft. vertical travel for the flight table. Maximum beam deflection is held to 0.017 in.

Beam ends are supported on 21,000-lb. reinforced concrete columns which in turn stand on eight 20-ft. pilings to assume stability.

The 750-lb. three-axis rotational head can carry a test instrument as heavy as 50 lbs.

Total permissible angular error for the system, Martin said, is 3.5 minutes of arc.

Radiation lab—A 30 x 45-ft. RF-shielded room and 22 x 22 x 25-ft. RF anechoic chamber make up the radiation lab. A flight table identical to that used in the optical lab is employed to support test devices.

Beam- and carriage-mounted in front of the flight table is a carriage for installing a radiator.

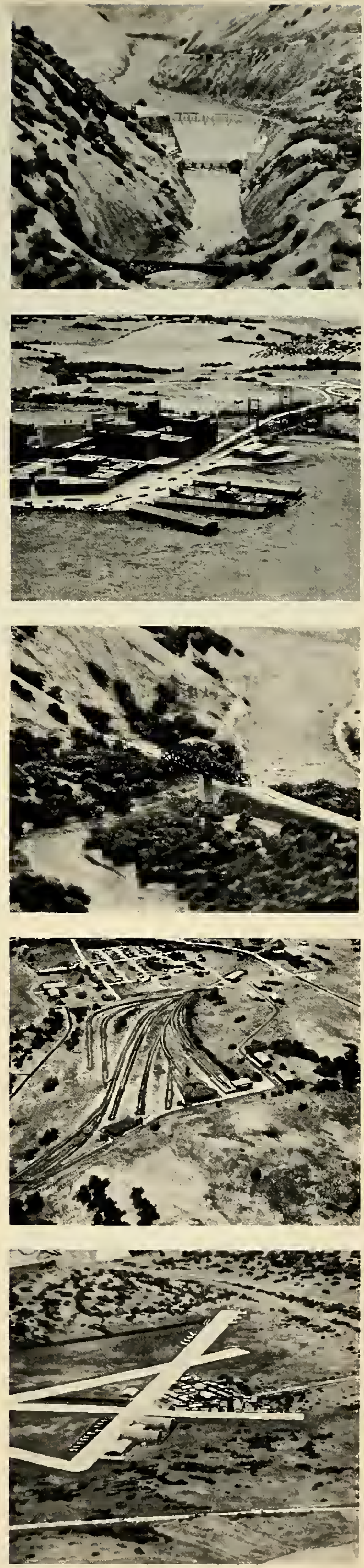
By opening the big door at the end of the optical lab, the device under test can be aimed outside at full-size radiating devices including low-flying aircraft.

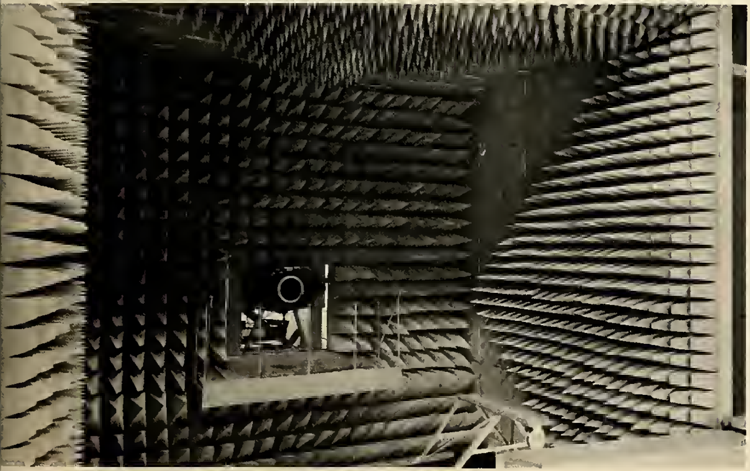
Computer facility—Supporting both major labs and the now incomplete pilot display lab is an extensive computer control center. Two Pace (231-R) analog computers, three X-Y plotters, a pair of 8-channel Brush recorders and a video tape recorder make up the heart of the facility.

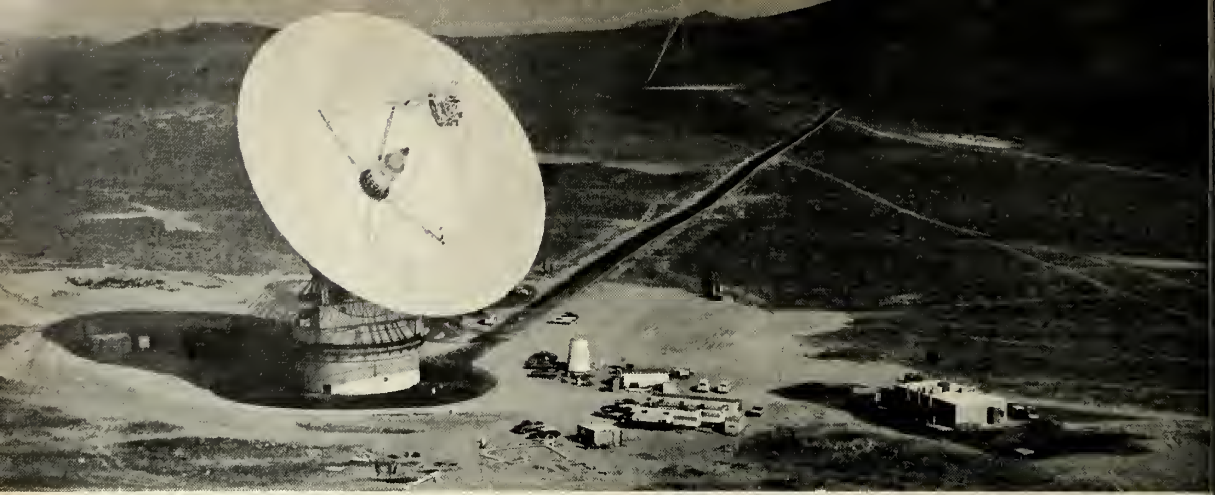
The control room also houses all the controls for lighting the optical lab.

With this facility, it is possible to simulate aerodynamics and dynamics of flight environments, missile airframe, and propulsion and control systems, as well as complete mission programming. ■

IGHT: Detail photos show uncannily realistic scale-model representations, included in g model shown on previous page, of typical targets for air-to-surface missiles. BELOW: nechoic chamber, measuring 37 x 38 x 26 ft., used at new center. Chamber is lined ith plastic absorbers to dissipate and minimize RF reflections and interference. Area uplicates environment of free-flying missile.







New 210-ft.-dia. tracking and communications antenna for use with the world-wi NASA/JPL Deep Space Network is stationed in the high desert near Goldstone, Ca

space electronics

Advanced Deep-Space Dish Readied

by Rex Pay

GOLDSTONE, CALIF.—A 210-ft. steerable antenna that will set the pattern for U.S. Deep Space Network ground terminals over the next 10 years will become operational within the next two months.

Built at an estimated cost of $14 million, the antenna is expected to track spacecraft out to the orbit of the planet Pluto.

The antenna has already been used to receive signals from *Pioneer 6* and from *Mariner IV's* omnidirectional antenna. It has also been used for a Sun occultation experiment.

When fully operational, the antenna's prime function will be communications with interplanetary spacecraft. Antennas of a similar size are expected to be constructed at other selected sites in the Deep Space Network around the world.

Carried on an elevation-over-azimuth mount, the aluminum parabolic dish and its supporting structure weigh nearly five million lbs. and rotate on a hydrostatic oil bearing. The periphery of the antenna is circular to within 0.05 in.; its parabolic contour is accurate to less than 0.25 in. Normal operating frequencies at S-band are 2,110 to 2,120 mc, transmitting, and 2,290 to 2,300 mc, receiving.

Prime contractor for design and construction of the antenna was Rohr Corp., Chula Vista, Calif. Contractor for the servo and control system was Dalmo-Victor Co., Belmont, Calif.

Dual modes—The antenna can operate in either programmed tracking or automatic tracking modes. A Cassegrain feed, terminated by a horn with a square throat divided into four equal apertures, provides the automatic tracking capability. A helium-cooled ruby maser amplifier feeds a four-channel S-band receiver, in which two channels are used for Doppler information, spacecraft telemetry, and scientific data (including television), and two channels carry antenna tracking data from automatic pointing.

Compared with the standard 85-ft. antennas currently used in the Deep Space Network, the 210-ft. dish will have 2½ times the range.

Whereas *Pioneer 6* could be followed for six months with an 85-ft. dish, it can be tracked for 14 months with the 210-ft. dish. The antenna can detect signals of 10^{-18} watt. A series of 210-ft. dishes linked in an array may be used to support manned interplanetary flights.

The 210-ft. dish and its structure weigh a total of 8,000 tons and reach 234 ft. above the desert floor at Goldstone. It is designed to operate in winds of 50 mph and to withstand winds of 120 mph.

Construction—The antenna base is a heavily reinforced concrete pedestal 83 ft. in diameter and weighing 10 million lbs. It is founded 11 ft. below ground; its 42-in.-thick walls rise 34 ft. above ground. Within the pedestal walls are housed the control room, machinery and equipment rooms, and the S-band and communications systems.

Dish and elevation mount are mounted on a five-sided steel fram work, or alidade, which stands on thr points whose bearing pads float on oil film supported by the main pedest Through the pedestal's center, but co pletely isolated from it, rises a 106- tower founded 33 ft. below grade. Tl provides a stable vibration-free pl form for instrumentation that reads o antenna pointing angles in polar c ordinates.

An autocollimator and star track for the precision angle data system w provided by Kollmorgen Corp. T master equatorial mount was provid by Boller and Chivens. Antenna e coders and master equatorial encode were provided by Data Technology, In and Datex Corp., respectively.

Since the antenna is chiefly intend for tracking planets and planeta spacecraft, it operates at sidereal trac ing rates, its maximum rates being abo 0.05° per sec. It is not suitable f tracking Earth satellites.

At sidereal rates in wind speeds u to 30 mph, the tracking accuracy expected to be 0.015° with programm pointing. With automatic tracking, t pointing accuracy is likely to be 0.03 Beamwidth of the antenna, betwe 3-db points, is 0.2°. An antenna surfa accuracy of 0.06 in. rms was specifi and this is believed to have be achieved.

Noise temperature of the system, expected to range from 23° to 25°

In normal operations, the st tracker is not used. It is intended f radio-astronomy operations as an alte native way to reference a star angle.

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ATS Ground Station Ready For Installation in Australia

Sylvania ground station to be installed Australia will complete ATS ground lin

WALTHAM, MASS.—Another milestone will be reached in the *Applications Technology Satellite* (*ATS*) project (M/R, Nov. 29, p. 91; March 7, p. 72) May 18 with shipment of a transportable ground station to Toowoomba, Australia, for installation and on-site checkout.

All station subsystems are now undergoing final operational testing at Sylvania's Electronic Systems Div. here. Sylvania designed the mobile station as part of a $3-million contract from NASA's Goddard Space Flight Center, *ATS* project manager. Two fixed-site stations, one at Mojave, Calif., and one at Rosman, N.C., complete the *ATS* ground-link chain.

Directed by NASA's Office of Space Sciences and Applications, *ATS* is an experimental program designed to extend the scope of spacecraft technology in communications and scientific observations at medium (6,000 n. mi.) and synchronous (22,300 n. mi.) Earth orbits.

Operational target—During a demonstration of the transportable station at Sylvania's plant April 21, Robert Farwell, program manager for the company, said the equipment should be "ready for business at the site by mid-September." At that time it will be turned over to the Australian Department of Supply for operation. About a dozen Australians are being trained on the station here, Farwell said.

Basic components of the station are an antenna/pedestal assembly and associated electronics. The 40-ft.-dia. parabolic antenna is transported unassembled on a flatbed trailer. A similar trailer carries the pedestal, plus jacking equipment and a boom crane to erect the assembly.

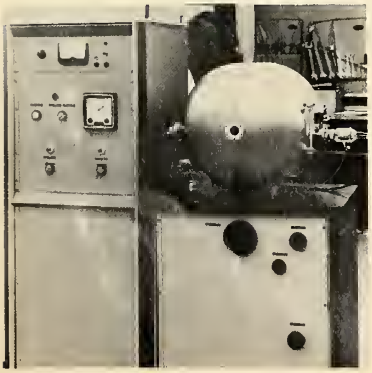
Three 40-ft. vans house the control electronics and another contains the telemetry and command-control subsystems; two other vans carry power-generating equipment. Five house-type trailers are supplied with the station for administrative and maintenance operations.

Antenna accuracy—According to R. W. Couch, Sylvania vice president and general manager of eastern operations, the station is capable of tracking the *ATS* satellites, at both the medium and synchronous altitudes, "with an accuracy of fifteen thousandths of a degree."

In addition to tracking the satellites, the station will participate in all spacecraft experiments by transmitting an receiving telemetry, television, multiple telephone, and command data.

Experiments to be conducted fro the spacecraft include checking of th gravity-gradient concept, which predic that a long object in space will alig itself vertically with the Earth; testin of a 10-micropound ion thrustor system microwave and VHF communicatio evaluations; meteorologic data-gathe ing, particularly of cloud formation an movement; de-spun antenna evaluation and orbital environmental measur ments.

New Product of the Week: Environmental Test Chamber



A stainless-steel environmental test chamber, combining high-vacuum and temperature test capabilities, has been announced by Materials Research Corp.

The Model VT-10 portable simulation chamber has a minimum of 1.5 cu. ft. of internal working area and offers adjustable vacuum capability approaching 1 x 10^{-8} torr (equivalent to an altitude of 1,500,000 ft.). Provision is made for controlled temperature capability from —300° to 350°F with ±2°F accuracy. Interior temperature surfaces are blackened for high emissivity.

The fully self-contained system features the stainless-steel chamber, vacuum pumping equipment, temper ture and vacuum controllers and i dicators, an internal removable shel vacuum feed-throughs and a 4-in. Pyre sight port. The unit is compatible wi commercial vacuum feed-throughs ar manipulation devices.

Circle No. 151 on Subscriber Service Card

PCM Signal Simulator

Astrodata, Inc., is marketing a sign simulator that generates time-mul plexed PCM formats to test and set u PCM decommutating equipment.

The model 613-100 PCM sign simulator features 100-bps to 1-mb bit rates, and an incrementing ID su frame sync word. Any frame leng from 1 to 799 words, with any wo length from 1 to 32 bits, can be ge erated.

Two sets of 32 toggle switches ea are used to select the main fran and subframe sync patterns. A third s of 32 toggle switches is used to sele the value of the common word.

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Advanced Systems Engineers	BSEE/MSEE/Physics	Huntsville, Ala.
Configuration/Interface Management Manager	BS Business Administration	Huntsville, Ala.
Systems Management Documentation Specialists	BS Business Administration	Huntsville, Ala.
Logistics Status & Control Engineers	BSME/EE	Kennedy Space Center, Fla.
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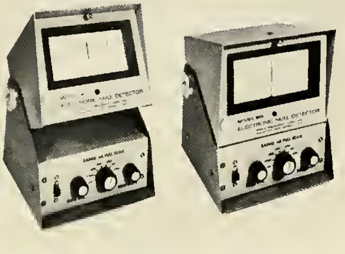
Any one of three different output formats is available with either normal or inverted polarity. The output can be filtered by a low-pass filter that is adjusted on the front panel, or the filter may be bypassed.

Circle No. 152 on Subscriber Service Cord

Electronic Null Detector

A sensitive electronic null detector has been developed by the Test and Service Products Div. of Radio Frequency Laboratories, Inc.

The solid-state design Model 485 features a large meter and offers both variable and fixed sensitivity. Operated from internal batteries, the unit has four full-scale ranges, from 0 to 10 to 0 to 10,000 nanoamperes. The unit also incorporates a sensitivity control and a tilting meter assembly for easy operator observation.



Capable of better than 1 nA resolution, the unit features components meeting ASA and NEMA specifications and readout from large 4½-in. taut band meter. Provisions are included for operation of the instrument with external recorder.

Circle No. 153 on Subscriber Service Cord

Ceramic Beam Pentode

A ceramic beam pentode with a third-order distortion level of at least — 40 db at 350 watts useful power output, Class AB_1, is being marketed by Machlett Laboratories, Inc., a subsidiary of Raytheon Co.

Model PL/8583/267 external-anode tube has a plate dissipation rating of 300 watts and is suited for use in single-sideband or multiplex applications where adjacent channel interference must be held to a minimum. The tube is 2.16 in. long and 1.75 in. in diameter. At full rated plate dissipation, the forced-air-cooled tube requires an air flow of 8 cfm at a pressure drop of 0.2-in. of water.

The unit uses a vane-type suppressor grid and an oxide-coated unipotential cathode. Required filament voltage is 26.5v at 1.0 ampere. Maximum plate voltage is 2,000v and maximum plate current is 350 milliamperes. Transconductance is 40,000 micromhos.

Circle No. 154 on Subscriber Service Cord

Video Noise Meter

A video noise meter that measures noise voltage in the presence of sync and blanking pulses has been developed by Rohde & Schwartz Sales Co., Inc.

Type UPSF is suitable for use in measuring noise voltages on TV cameras, film scanners and video tape recorders, radio links, coaxial lines, and TV transmitters, receivers and transposers. It can be used for both weighted and unweighted noise voltages and can also be used as a conventional VTVM.

The instrument meets the requirements of all U.S. black-and-white and NTS color systems and has a 40-Hz to 5-MHz frequency range. It has seven measurement ranges (1, 3, 10, 30, 100, 300 and 1,000 mvpp). The unit provides both RMS or peak-to-peak indications. Its output impedance is 1 megohm shunted by 30 pF, or 75 megohms bridging, and it has an output for an oscilloscope.

Circle No. 155 on Subscriber Service Cord

Transistor Amplifier

A high-gain transistor amplifier for narrow-band applications is being marketed by Micro State Electronics Corp., subsidiary of Raytheon Corp.

Model TQN-0030 operates at 30 mc with a 2-mc bandwidth. It provides a gain of 100 db minimum. Actual noise figure is 2.5 db maximum. The quiescent current drain is ±6v at 1.5 milliamperes.

The 100-db minimum gain characteristic is provided with a stability of ±3 db to an operating temperature range of —25° to 75°C.

Circle No. 156 on Subscriber Service Cord

Tape Loop Transport

A magnetic tape loop transport that may also be used as a digital memory/buffer with removable media has been introduced by S. Himmelstein and Co.

The Impellor II features pneumatic tape drive, tape tensioning, tape buffering and dynamic braking. Pinch rollers have been eliminated so that only the heads touch the tape oxide

Tape speeds of 240, 120, 60, 30, 15 and 7.5 ips are standard. Loop repetition rates of 6.7 per second are obtainable. The machine will handle ¼-in., ½-in., or 1-in.-wide paper, plastic or metal-base tapes. Tape loop lengths may be from 36 in. to 650 ft. Accurately calibrated two-axis head positioners are also available.

Circle No. 157 on Subscriber Service Cord

Tape Erasers

A line of portable magnetic tape bulk erasers capable of erasing saturated tapes at the rate of 100 to 250 reels per hour has been announced by Fe ranti Electric, Inc.

Portable Models No. 6, 7, and 8 a static instruments without electric moving parts and they provide insta erasure to reels of tape without leavi a tape hiss or background hum. A recorded data, audio pulses, or any kin of signal, from DC to video, is erase to better than 80 db below saturatic recording level.

Model No. 8 handles reels of ma netic tape up to 14½-in. in diamet and accommodates ¼-in.- to 2-in. wid tapes. Model No. 7 is suitable for co tinuous tape cartridges of a size n exceeding 8-in. square with maximu tape width of 1 in. for broadcastin studios. Model No. 6 handles reels u to 8¼-in. in diameter and accomm dates ¼-in. to 1-in. width tapes.

Circle No. 158 on Subscriber Service Cord

Pulse Generator

A 40-MHz pulse generator with i dependently variable linear rise and fa to 2 μsecs, single- or double-pulse ou puts to ±5v and precision baseline of set is available from Datapulse, Inc.

Model 111 features variable puls delay from 10 μsecs advance to 50 mill secs delay and leading edge to leadin edge double-pulse separation to 20 μsec Pulse width is continuously variab from 5 μsecs to 500 microsecs. Dela and duration duty cycles are at lea 40% at 40 MHz. Jitter is less tha 0.01%.

Repetition rate range is 4 Hz to 4 MHz in single-pulse mode. Maximu repetition rate of 25 MHz in doubl pulse mode provides a simulated 5 MHz. External triggering requires ±1.0v pulse. Input impedance is selec able by panel switch as 50 or 500 ohm

Circle No. 159 on Subscriber Service Cord

Infrared Microscope

A fast-scanning infrared microscop for microcircuit evaluation has bee developed by Raytheon Co.

The scanner is capable of spati resolution of 10 microns, temperatu resolution of 1°C, and maximum sca speed of 10 fps. This capability mak possible evaluation of semiconducto during transient conditions before the mal equilibrium is reached, accordi to the firm.

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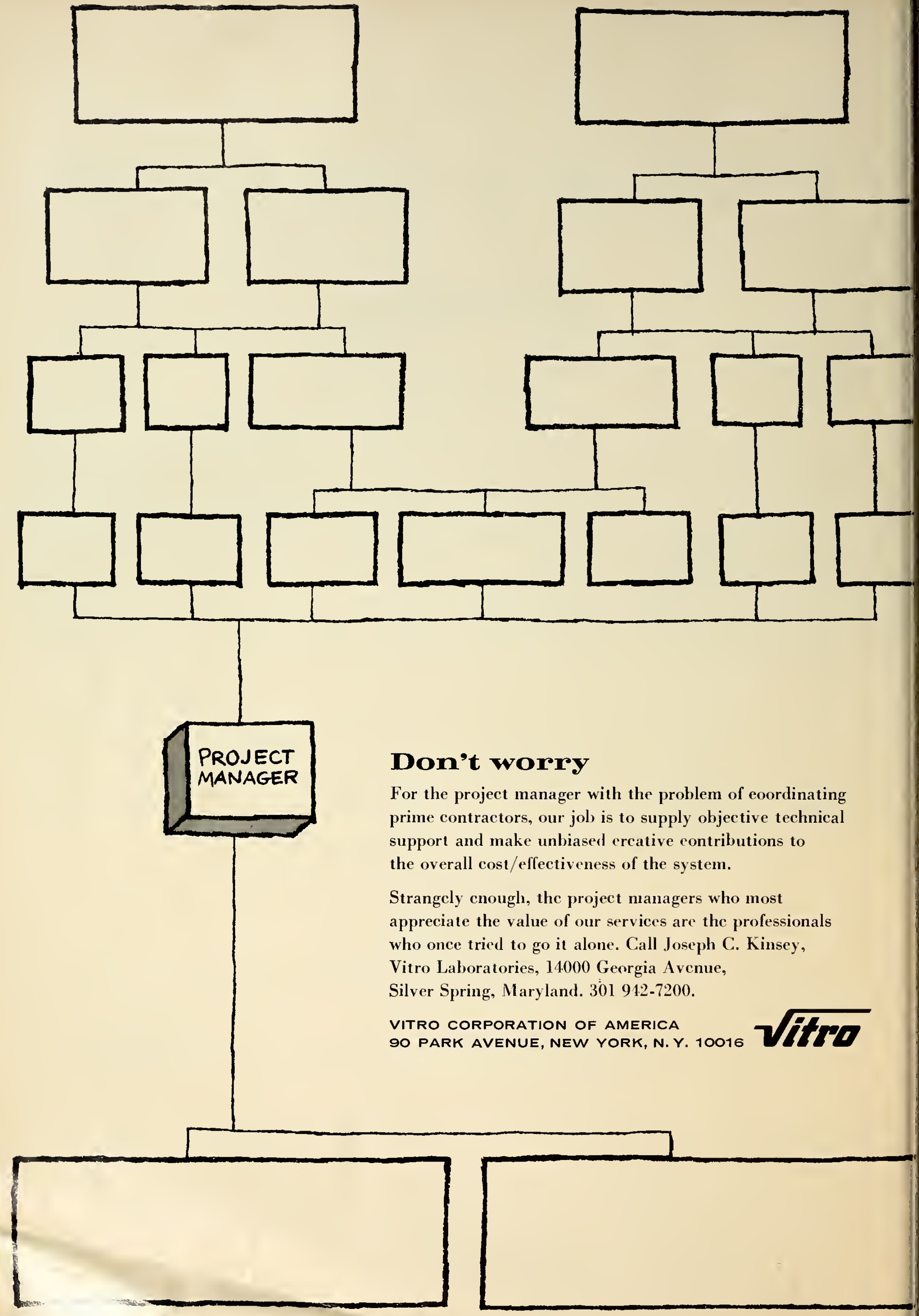

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The Industry Week

Mergers and Acquisitions

Honeywell, Inc., Minneapolis, has completed acquisition of Electro Instruments, Inc., San Diego, Calif. Under the plan, one share of Honeywell common stock will be exchanged for each eight shares of Electro Instruments common stock. The transaction will total more than $7 million. Electro Instruments, which produces test instrumentation, will be operated as a unit of Honeywell's Test Instruments Div. . . . *RdF Corp., Hudson, N.H., has incorporated RdF West, a wholly owned subsidiary located in Westminster, Calif., into the parent firm. RdF West will design and manufacture solid-state electronic signal conditioners.* . . . G. T. Schjeldahl Co., Northfield, Mass., has purchased the assets of GCA Corp.'s Viron Div., Fridley, Minn. Viron specialized in design and manufacture of inflatable space structures, inflation systems, balloons and expandable materials for aerospace use. The total operation will be transferred to Northfield and absorbed into Schjeldahl's Advanced Programs Div. . . . *U.S. Polymeric, Inc., Santa Ana, Calif., has purchased Parr Molding Compounds Corp., Stamford, Conn. U.S. Polymeric manufactures preimpregnated plastics for the aerospace, aircraft and electrical/electronic industries. Parr molding compounds include alkyds, polyesters and diallyl phthalates.*

International

General Dynamics, New York City, has completed a license agreement with Supramar, Ltd., Lucerne, Switzerland, to manufacture and sell hydrofoil boats in the western hemisphere based on Supramar patents and engineered drawings. GD/Convair, San Diego, Calif., has been given responsibility for the hydrofoil programs. . . . *Sel-Rex Corp., Nutley, N.J., is building a plant in Helvoirt, Holland, for the manufacture of Sel-Rex precious metal plating supplies.*

New Activities

Sylvania Electric Products, Inc., New York City, has opened a field office in Conrad, Mont., to direct installation of an underground communications network for the Air Force *Minuteman* ICBM. Approximately 350 mi. of communications cable will be buried to link 50 *Minuteman* missiles and five underground launch control centers. . . . *Microcircuits, Inc., has been established in Canoga Park, Calif., by Redcor Corp., manufacturer of geophysical and aerospace data acquisition systems. The new firm will produce thick-film hybrid integrated circuits. President is Robert Olander.* . . . PLS Associates has been formed in Englewood, Colo., to represent electronics manufacturers in the Rocky Mountain area. The company was established by Peter Lahana, formerly with Hewlett-Packard Co. . . . *Pulse Communications, Inc., Alexandria, Va., has formed a new Instrumentation Div. to help expand the firm's capability in sounding rocket and oceanographic instrumentation. The company has also increased its plant facilities by 50%.*

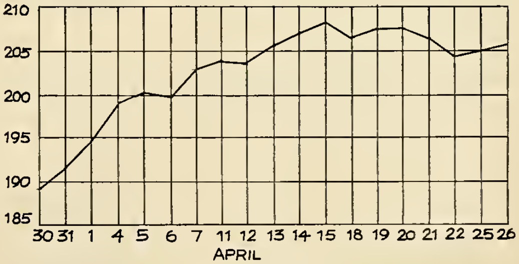
Company Representatives

Bendix Corp.'s Filter Div., Madison Heights, Mich., has appointed Garsite Products, Inc., Seaford, N.Y., as distributor for its line of Go-No-Go gages in the northeastern United States. . . . *Parelco, Inc., Los Angeles, manufacturer of miniature relays, has named W. Ben Wimberly Co., Clearwater and Orlando, Fla., sales representative for the state of Florida.* . . . Burroughs Corp.'s Electronic Components Div., Plainfield, N.J., has appointed Reynolds & Associates, Eau Gallie, Fla., engineering sales representative for Florida, Georgia, Alabama and part of Tennessee. Reynolds will handle the Burroughs line of NIXIE tubes, associated modules and ferrite memory devices.

Industry Facilities

Philco Corp.'s Aeronutronic Div., Newport Beach, Calif., has moved into additional production facilities at 1001 E. Ball Rd., Anaheim, Calif. The 130,000-sq.-ft. plant will be under the direction of Arthur C. Haines, director of operations for Aeronutronic. The division has also installed a $292,000 vibration test system in the environmental test area at Newport Beach. The system will be used initially to support Aeronutronic's re-entry measurements program. . . . *A $360,700 research facility, designed to test experimental rocket engines with chamber pressures up to 4,000 psia, is under construction at Bell Aerosystems Co.'s Rocket Test Center, Model City, N.Y. The facility, expected to be operational in August, will be capable of testing engines with thrust ratings from 10 to 20,000 lbs.* . . . Te Co., Santa Barbara, Calif., optics research and development firm, is expanding its production facilities. A new structure for additional space for laboratories, custom optical fabrication and engineering, is expected to be completed in October. Main features will include a vibration isolated island and a large collimator/spectrometer. . . . *Reeves Instrument Co., a division of Dynamics Corp. of America in Garden City, N.Y., has opened a new hybrid computation facility for use in engineering design and simulation and evaluation of dynamic systems.* . . . High Vacuum Equipment Corp., Hingham, Mass., has begun construction of a 12,000-sq.-ft. addition to its present building.

Missile/Space Stock Index



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC. 31, 1964
STOCK PRICES FURNISHED BY MERRILL LYNCH, PIERCE, FENNER AND SMITH

Contracts and Procurements

AWARDS

AIR FORCE

$6,750,000—**Hughes Aircraft Co.**, Fullerton, Calif., initial segment of $13,500,000 contract for advanced radar systems.

$900,000—**Radio Corp. of America**, Missile & Surface Radar Div., Moorestown, N.J., for coherent signal processors for MIPAR radars.

$500,000—**Sylvania Electric Products, Inc.**, Waltham, Mass., to study modifications in the command and control systems of the *Minuteman II* ICBM.

$375,000—**Aerojet-General Corp.**, Solid Rocket Plant, Sacramento, Calif., for 41 Alcor rocket motors.

$350,000—**Honeywell, Inc.**, St. Petersburg, Fla., for gimballed electrostatic inertial navigator test program.

$200,000—**Ion Physics Corp.**, Burlington, Mass., to develop ion implantation techniques to fabricate thin silicon solar cells.

$86,545—**IIT Research Institute**, Chicago, for R&D on extravehicular protective assemblies.

$85,000—**Martin Co.**, Baltimore, for design criteria for in-space maintenance.

$83,194—**Northrop Corp.**, Northrop Space Laboratories, Hawthorne, Calif., for UV measurements and testing program.

$73,347—**Douglas Aircraft Co., Inc.**, Missile & Space Systems Div. Santa Monica, Calif., for Marcas II ablation study.

$65,140—**Spacerays, Inc.**, Dayton, Ohio, for laser beam spreader.

$50,000—**Goodyear Aerospace Corp.**, Litchfield Park, Ariz., for acceleration of *Minuteman* transporter schedule.

$29,812—**Hughes Aircraft Co.**, Hughes Research Laboratories Div., Malibu, Calif., for gaseous ion laser research.

$25,000—**Ralph M. Parsons Co.**, Los Angeles, for studies, investigations, evaluation, testing and monitoring of test programs for *Minuteman* high-explosive simulation test programs.

$10,523—**North American Aviation, Inc.**, Rocketdyne Div., Canoga Park, Calif., for specialized spares for *Atlas* propulsion subsystems in support of *Abres/Nike-X* program.

ARMY

$19,093,947—**Thiokol Chemical Corp.**, Marshall, Tex., addition to existing contract for illuminating cartridges and signals.

$9,312,152—**Hercules Powder Co.**, Wilmington, Del., for continued production of rocket-propellant grains and for operation and maintenance of an Army ammunition plant at Lawrence, Kansas.

$8,000,000—**Atlantic Research Corp.**, Alexandria, Va., in two contracts for production of advanced ordnance devices and ordnance dispensing equipment.

$3,964,033—**Silas Mason & Co.**, Burlington, Iowa, addition to existing contract for various ordnance items.

$3,118,750—**Hughes Aircraft Co.**, Fullerton, Calif., for radio sets and transmitters.

$2,750,000—**Western Electric Co.**, New York City, modification to an existing contract for *Nike-Hercules* improved modification kits.

$1,872,138—**Raytheon Co.**, Andover, Mass., letter contract for engineering services for self-propelled *Hawk* system.

$1,686,775—**Philco Corp.**, Aeronutronic Div., Newport Beach, Calif., for acceptance inspection equipment for *Shillelagh*. Also, $1,302,000 for initial equipment maintenance for the *Shillelagh* missile system. Also, $682,000 for technical assistance to the *Shillelagh* second source.

$74,924—**Spaco, Inc.**, Huntsville, Ala., for laser research study.

$66,514—**Astro-Space Labs, Inc.**, Huntsville, Ala., for 12-month R&D engineering support effort for inertial guidance and control laboratory.

$37,121—**Lockheed Aircraft Corp.**, Lockheed Missiles and Space Co., Sunnyvale, Calif., for services for study to determine injectant and injection geometry of a thrust rocket motor.

NAVY

$5,000,000—**Radio Corp. of America**, Communications Systems Div., Camden, N.J., for modification to contract for radio sets and parts.

$4,218,000—**Bermite Powder Co.**, Saugus, Calif., multi-year, fixed-price contract for Jato rocket motors.

$3,931,215—**General Motors Corp.**, Milwaukee, for design, development and construction of two prototype systems.

$2,023,158—**Raytheon Co.**, Lexington, Mass., for services to enhance operational effectiveness and reliability of the *Sparrow* missile.

$1,900,000—**Sperry Rand Corp.**, Great Neck, N.Y., to produce instrumentation radars for the U.S. Navy underwater tactical range.

$286,144—**Zero Manufacturing Co.**, Monson, Mass., for metal reusable shipping containers for *Sparrow III*.

$250,000—**General Electric Co.**, Ordnance Dept., Pittsfield, Mass., for improvement of *Talos* guided missile launching system Mk 12.

$200,000—**Honeywell, Inc.**, Ordnance Div., Hopkins, Minn., for habilitation of part of a building at Naval Torpedo Station, Keysport, Wash., for use with the Mk 46 torpedo program.

$109,997—**General Precision, Inc.**, GPL Div., Pleasantville, N.Y., for research to develop an optical nuclear gyroscope.

NASA

$21,000,000—**Brown Engineering Co., Inc.**, Huntsville, Ala., contractual renewal for engineering support at the Marshall Space Flight Center.

$4,969,277—**Hayes International Corp.**, Birmingham, Ala., from Marshall Space Flight Center as second year of a five-year option for engineering, tooling, fabrication and related technical services at Hayes facilities and Marshall's manufacturing engineering laboratory.

$1,139,000—**C&R Builders**, Seattle, Wash., from Goddard Space Flight Center for construction of expansion of facilities at NASA's Alaska data acquisition facility, Fairbanks, Alaska.

$360,000—**International Telephone and Telegraph Corp.**, Federal Laboratories, Nutley, N.J., from Goddard Space Flight Center for a time-division multiple-access communication system for experiments with the orbiting *Relay* satellite.

$200,000—**Radio Corp. of America**, Astro-Electronics Div., Princeton, N.J., increase in contract for the *Nimbus* program.

$134,000—**LTV Aerospace Corp.**, Dallas, from Marshall Space Flight Center for research on definition of experiment program in space operations techniques and subsystems on extravehicular manipulations.

$94,674—**Sylvania Electric Products, Inc.**, Sylvania Electronic Systems-Central, Williamsville, N.Y., from Marshall Space Flight Center for additional research and advanced studies on coherent light tracking techniques.

$77,850—**General Electric Co.**, Philadelphia, from Goddard Space Flight Center for operation of *Nimbus* technical control center for *Nimbus B*.

$70,518—**Marquardt Corp.**, Van Nuys, Calif., from Manned Spacecraft Center for *Apollo* service rocket engines and injection valves.

INDUSTRY

$9,000,000—**Hercules Powder Co.**, Wilmington, Del., from **Westinghouse Electric Corp.**, New York City, to develop a launch eject system for the Navy's proposed new fleet ballistic missile.

$7,000,000—**Clary Corp.**, San Gabriel, Calif., from **Philco Corp.**, Philadelphia, for gyroscopes for *Shillelagh*.

$2,825,000—**Electronic Communications, Inc.**, St. Petersburg, Fla., from **Boeing Co.**, Seattle, Wash., for special purpose communication equipment for advanced *Minuteman* missiles.

$1,200,000—**Westinghouse Electric Corp.**, Blairsville, Pa., from **Philco Corp.**, Aeronutronic Div., Newport Beach, Calif., for components used in *Shillelagh* missile.

$1,000,000—**Watkins-Johnson Co.**, Palo Alt
Calif., from **Emerson Electric Co.**, St. Loui
Mo., for seven programmable signal sources.

$480,000—**Consolidated Electrodynamics Corp**
Pasadena, Calif., from **Electronic Specialty Co**
Los Angeles, for predetection magnetic-ta
recorders to be used as part of three groun
based telemetry systems at Western Te
Range.

$400,000—**United Control Corp.**, Redmon
Wash., from **Boeing Co.**, Seattle, Wash., f
temperature control sets for use with *Minut*
man II.

$370,000—**Microdot, Inc.**, South Pasadena, Calif
from **Philco Corp.**, Aeronutronic Div., Ne
port Beach, Calif., for subminiature connecto
for use on *Shillelagh* missile electronic packag

$329,117—**Nubar Industries, Inc.**, Orlando, Fla
from **Martin Co.**, Baltimore, for shipping co
tainers for the *Walleye* weapon program.

$283,000—**Computer Control Co.**, Framingha
Mass., from **Sylvania Electric Products, Inc**
New York City, for a digital computer syste
for a long-range tracking and instrumentati
radar to aid anti-missile studies.

$230,000—**International Telephone and Telegra**
Corp., Federal Laboratories, Nutley, N.J., fro
Communications Satellite Corp., Washingto
D.C., for modulation, demodulation, termin
and associated equipment for Comsat Corp.
Brewster Flat, Wash., Earth station.

$190,000—**Raymond Engineering Laboratory**, Mi
dletown, Conn., from **Computing Devices**
Canada for recorder/reproducers.

$90,000—**Allen-Bradley Co.**, Milwaukee, fro
Boeing Co., Seattle, Wash., for filters to
used on *Minuteman II*.

$16,480—**Conic Corp.**, San Diego, Calif., fro
Lockheed Aircraft Corp., Lockheed Missil
and Space Co., Sunnyvale, Calif., for solid-sta
telemetry transmitters.

International Telephone and Telegraph Cor
Federal Laboratories, Nutley, N.J., from **Pa**
Communications Engineers, Inc., Washingto
D.C., for monopulse tracking receiver syste
for Comsat Corp., with deliveries set for Jun
Amount not disclosed.

Philco Italiana S.A., Rome, Italy, (subsidiary
Philco Corp., Philadelphia) from the Itali
satellite communications organization, Tel
spazio, for an antenna system, including a 9
ft.-dia. reflector, to be part of a commerci
satellite communications terminal at Fucin
work is expected to be completed in 15 month

REQUEST FOR BIDS

Contracting Officer
National Aeronautics and Space Administratio
Langley Station
Hampton, Va.

Langley Research Center will conduct negoti
tions with the Geotech Div. of Teledyne Industri
Inc., Garland, Tex., for a contract covering a
search study of the seismic effects of sonic boo
For information only; RFP not available.

Purchasing Office
National Aeronautics and Space Administration
George C. Marshall Space Flight Center
Huntsville, Ala. 35812

Negotiations will be conducted with Sper
Phoenix Co., Div. of Sperry Rand Corp., Phoeni
Ariz., for non-severable continuation of wo
being performed under contract NAS8-20080 f
application of tracking filter to stabilize large fle
ible launch vehicles. For information only; R
not available.

Nike-X Project Office
U.S. Army Materiel Command
Redstone Arsenal, Ala.

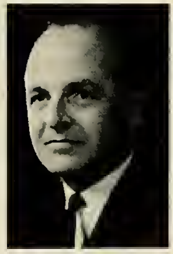
Proposes to solicit a quotation from Phot
Sonics, Inc., Burbank, Calif., for two cine-s
tant tracking mount systems for use at Kwajale
Test Site. For information only; RFP not ava
able.

Names in the News

LEONARD

DAVIS

HAWLEY



FISCHER

Edward J. Leonard: Named vice presi-nt for marketing and engineering of omTech Corp. The company, a sub-liary of Reliable Electric Co., serves ilitary and industrial organizations in the mmunications industry.

William A. Davis, Jr.: Selected for an fred P. Sloan Fellowship at the Massa-usetts Institute of Technology. He is an my Missile Command scientist, re-wned for his work in laser research. The ogram is a one-year training program signed for young executives from private dustry and government who have dem-strated outstanding management poten-l.

Mones E. Hawley: Named by Planning search Corp. to head the firm's Systems onomics Div. Formerly manager of the ean systems and simulation department, will direct the work of four depart-ents.

Harris Fischer: Appointed vice president charge of manufacturing for Avnet, Inc. will continue as president of Valley rge Products, Inc., a division of the mpany.

James S. Rice: Appointed director of rth American staff of International lephone and Telegraph Corp. He will be sponsible for the support of ITT's North nerican manufacturing, research and es activities.

Dr. Henri G. Busignies: Elected a ember of the National Academy of En-neering for his work in aerial navigation stems. He is a senior vice president and neral technical director of International lephone and Telegraph Corp.

Dr. John Blair: Joined Raytheon Co. corporate director of research and scien-c liaison. He is a former Massachusetts stitute of Technology associate professor electrical engineering and consultant to number of electronics firms.

George J. Maler: Will become associ- dean of the University of Colorado llege of Engineering.

John C. Duffy: Appointed chairman of neral Precision Equipment Corp.'s prod-t assurance council. He is chief of value gineering at the GPL Div. of General ecision's aerospace group.

Leslie H. Warner: Named chief executive officer of General Telephone and Electronics Corp. He succeeds **Donald C. Power,** who will continue as chairman of the board.

Richard W. Jones: Elected a director of General Telephone & Electronics Corp. He is president of Mitchum, Jones & Templeton, Inc. He is also director of Wayne Manufacturing Co., Strolee of California, Wyle Labs, West Bay Financial Corp., General Telephone Directory Co., and Charter Life Insurance Co.

Robert C. Pittman: Elected senior vice president of the Federal Electric Corp. **Dana Denison** was named vice president.

Thomas W. Easton: Appointed divisional vice president of operations of the St. Petersburg Div. of Electronic Communications, Inc. He will be responsible for all factory operations at the division, including manufacturing, materiel and quality control.

Guerard H. Howkins, Jr.: Named controller for Raytheon Co.'s Space and Information Systems Div. Prior to joining Raytheon, he administered engineering programs for Anderson-Nichols & Co.

Jack Roseman: Named vice president and manager of Heliodyne Corp.'s Washington operations. Heliodyne is a research organization specializing in interdisciplinary approaches to scientific problems.

Albert W. Baker, Charles R. Gollihar and Wellwood S. Beall: Elected directors of the board of the Douglas Aircraft Co. of Canada, Ltd. Re-elected chairman of the board was **Donald W. Douglas, Jr.; Jackson McGowen** was re-elected president.

Dr. Clarence F. Luck, Jr.: Granted a patent on his invention of a novel elliptical reflector for lasers. With the invention, the efficiency of the transfer of light essential to laser action is increased greatly. He is a principal engineer at Raytheon Co.

Dr. Vannevar Bush: Received the first Founders' Medal of the National Academy of Engineering. He mobilized this country's scientific and technical resources for war and created the blue print for the post-war cooperation of science and government.

Missiles & Rockets will publish a Special Report on the U.S. Military Space Program on May 30, 1966. Reserve your advertising now —

Closing Date: May 16

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When and Where

MAY

Canadian Aeronautics & Space Instrument Annual General Meeting, Chateau Laurier, Ottawa, Canada, May 2-3.

Communications Satellite Systems Conference, sponsored by the American Institute of Aeronautics and Astronautics, Mayflower Hotel, Washington, D.C., May 2-4.

12th National Instrument Society of America Aerospace Instrumentation Symposium, Marriott Motor Hotel, Philadelphia, May 2-4.

Integrated Circuit Economics & Basic Technology Seminar, sponsored by the Integrated Circuit Engineering Corp. of Phoenix, Ariz., Washington, D.C., May 2-6.

25th Annual National Conference of the Society of Aeronautical Weight Engineers, Hilton Inn, San Diego, Calif., May 2-5.

Third Bionics Symposium, sponsored by the Aerospace Medical Research Laboratories, the Air Force Avionics Laboratory of Wright-Patterson AFB, Sheraton-Dayton Hotel, Dayton, Ohio, May 3-5.

1966 Program Electronic Components Conference, sponsored by the Electronic Industries Association, Institute of Electrical and Electronics Engineers, Marriott Twin Bridges Motor Hotel, Washington, D.C., May 4-6.

Virginia Academy of Science Annual Meeting, Madison College, Harrisonburg, Va., May 4-7.

Second Annual Conference of Atmospheric Contamination in Confined Spaces, sponsored by the Aerospace Medical Research Laboratories, Aerojet General Corp., Imperial House North Motel, Dayton, Ohio, May 4-5.

Seventh Symposium on Human Factors in Electronics, sponsored by the Institute of Electrical and Electronics Engineers, Radisson Hotel, Minneapolis, May 5-6.

Kansas Academy of Science Annual Meeting, Washburn University, Topeka, Kan., May 5-7.

68th Annual Meeting of the American Ceramic Society, Sheraton-Park Hotel, Washington, D.C., May 7-12.

Third National Conference of Standards Laboratories, National Bureau of Standards, Gaithersburg, Md., May 9-12.

Ninth Midwest Symposium on Circuit Theory, sponsored by the Institute of Electrical and Electronics Engineers, Oklahoma State University, Stillwater, Okla., May 9-10.

Design Engineering Conference, sponsored by the machine design division of the American Society of Mechanical Engineers, McCormick Place, Chicago, May 9-12.

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10

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Advertising closes: July 12, 1966

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AN AMERICAN AVIATION PUBLICATION ☐ 1001 VERMONT AVE., N.W. ☐ WASHINGTON, D.C. 20005

No Second Best

THE JOHNSON ADMINISTRATION has left itself in a vulnerable and politically indefensible position in the race with the Russians to achieve the first manned lunar landing.

This is a most curious situation for a President who has declared his determination to be first in the race and who at all times demonstrates keen political insight.

The question that no one in the Administration seems to have asked is this: What happens if the Russians win the race?

Since the most knowledgeable officials in the National Aeronautics and Space Administration, including Administrator James E. Webb, concede that there is at least a 50-50 chance of this unpleasant event taking place, some contingency planning would seem to be in order.

There is, to date, no sign of this. The U.S. has set a manned lunar landing—indeed, the *first* manned lunar landing—as a national goal. The *Apollo* landing was selected by the Kennedy Administration precisely because it was the first major space goal to which we might be expected to beat the Soviet Union.

A defeat in this race, as it stands, would be a worldwide propaganda disgrace because we ourselves chose the target. It also could be a crushing political blow at home to the President linked with it, which the present White House incumbent has been from the inception. It is worth noting that the year in which the Russians are most likely to bring this off, if they do succeed, is 1968, the year of the next Presidential election.

Intermediate objectives which the Soviet Union achieves first, such as extravehicular activity or the first unmanned soft-landing on the Moon, can be brushed off as of secondary importance, or as something which our broader-based, more capable program will achieve in due course en route to the basic objective.

The same is not true of the manned lunar landing. There are only two entrants in the race. *You can't come in second better.*

It is necessary to ask, therefore, if the Russians do stand a chance of beating us to the Moon. Any speculation on the shrouded Soviet program always is fraught with uncertainty. Yet there are distinct waypoints which indicate the Russians are well along the road to a lunar landing. If they are planning to employ assembly in Earth orbit in their attempt, as it appears they will do, EVA is very important to them. They have achieved this. If they are planning to land, as contrasted with a circumlunar fly-by, then an unmanned soft landing on the Moon would be a necessary part of the program. They have achieved this. Rendezvous and docking in orbit also would be required. They have not yet achieved this, and their success in doing so will be a significant clue as to their progress.

The U.S., on the other hand, has accomplished rendezvous and docking and EVA but has yet to achieve the soft landing. Its program also rests on a yet-untried booster. The Earth-orbital approach might make it possible for the Soviet Union to reach the Moon with its now-tested launch vehicle for *Proton.*

These and other factors add up to the conclusion that 50-50 odds on the chances of the two entrants may not be a bad guess.

THE QUESTION which the White House should be asking is what can be done to soften the propaganda defeat and avert the politically explosive domestic situation which would result from a Soviet victory in the race.

The answer would seem to be this: extend the U.S. national goal prior to a manned lunar landing by either the U.S. or the Soviet Union. Then, if the Russians were the first to arrive on the Moon, we would be in a position to gracefully acknowledge their achievement while pointing out that to us the Moon was but a way-station en route to a more distant objective. If we accomplished the first landing, we would also have the benefits of victory. But we would not be so exposed in the event of a defeat.

There are, of course, a number of such manned objectives which could be reached with the hardware for the *Apollo* program, a criterion for immediate post-*Apollo* objectives which has been laid down by the Administration. These would include an extensive program of lunar exploration, planetary fly-bys, orbital space stations of various types, and—with some slight additional capability—landings on Mars or Venus.

Selection of one of these would have the added attraction of continuing to support the space capability which the U.S. has built in the *Apollo* program. Because the lunar landing itself still is some time off, it is not generally recognized that this capability already is beginning to erode. Much of the design work on the *Apollo* project has been accomplished, and there is relatively little to hold the design teams together. Fiscal '68 will see the end of Lunar Excursion Module and *Saturn V* production under present schedules.

Without establishment of a higher goal and a greater challenge, U.S. space capability will dissipate. NASA efforts to prevent this by getting a worthwhile *Apollo* Applications Program under way have not met with notable success. This provides a second good reason for lifting our national goal.

It would appear unpalatable politically to set a second goal before the first is reached. But there would seem to be no such difficulty, in the light of what the U.S. already has accomplished in space, in a Presidential declaration that our national objective has been raised, perhaps to a Martian fly-by.

Without such contingency planning, a Soviet victory in the lunar race will result in a worldwide propaganda disaster and quite possibly a domestic political disaster for the President.

William J. Coughlin

ur Armed Forces in Southeast Asia and in other corners of the world are now using the AN/TRC-80, originally designed for use with e Pershing Missile System, for point-to-point tactical communications. It provides one duplex voice channel and one half-duplex eletype channel. It can be put into full operation by a two-man crew within 10 minutes of its arrival by helicopter or land transport.

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1371	5,278	1291	14,044
1039	22,798	1101	17,251
1097	20,286	1582	18,064
1230	5,890	1515	11,281
1014	11,233	1506	11,658
1585	10,288	1393	3,909
1229	4,368	1522	9,160
1087	22,630	1440	10,092
1103	6,920	1352	8,394
1211	20,400	1402	6,224
1092	19,820	1373	11,791

3uilt by Collins Radio Company and powered by Varian's /A-834B klystron, the AN/TRC-80 Portable Tropo-pheric Scatter Communication Terminal is one of the nost successful microwave systems in use at this time. ts exceptional performance record rests to a large neasure on the remarkable dependability of the /A-834B. Guaranteed for a life span of 1,000 hours, these klystrons have averaged an actual operating life of over *12,000 hours* under field conditions.

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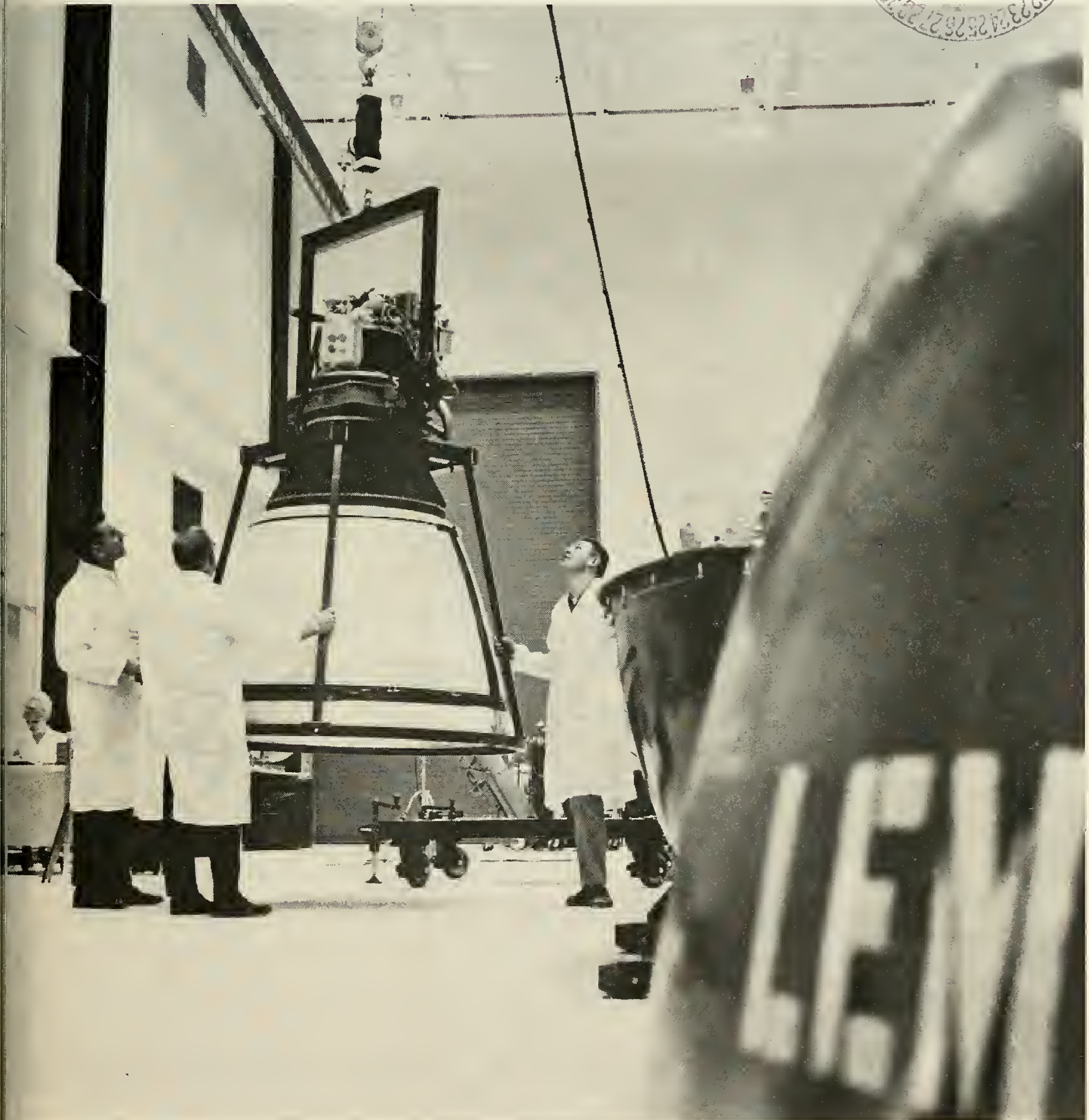

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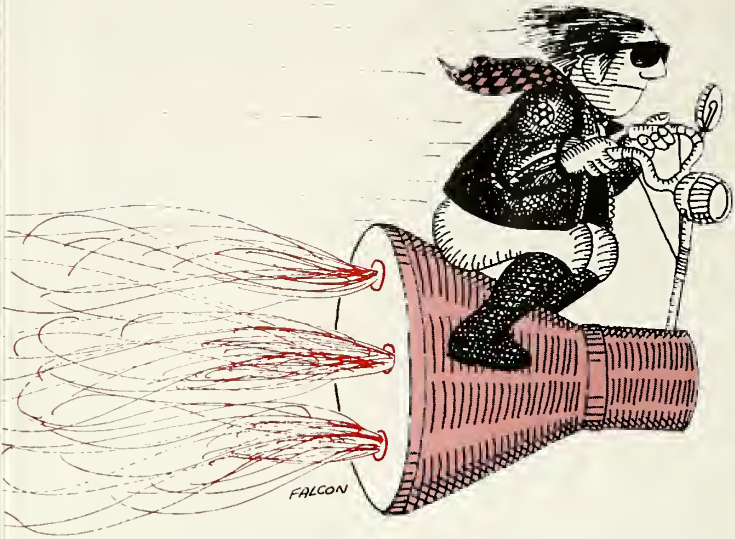

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Volume 18, Number 19 May 9, 1966

missiles and rockets

THE WEEKLY OF ADVANCED TECHNOLOGY

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THE COVER

First development model of the engine that will soft-land Apollo astronauts on the lunar surface is shown being delivered to Grumman Aircraft Engineering Corp. by TRW Systems Group. The engine will be integrated into Grumman's Lunar Excursion Module now being readied for systems tests at NASA's White Sands Proving Grounds site.

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Letters

SILASTIC Not Generic

To the Editor:

In your otherwise excellent article by Heather M. David, "Hospital To Benefit from Space Work" (M/R, Feb. 28, p. 26), you used the trademark SILASTIC® in a generic sense. The mark SILASTIC is a trademark of Dow Corning Corporation and is not a synonym for silicone rubber.

We, of course, appreciate the fact that it is difficult to give proper credit to all trademarks and do not imply any bad intent on your part. However, we request that in the future you use the trademark SILASTIC in the proper trademark sense.

Neil R. Mitchell
Legal Department
Dow Corning Corporation
Midland, Michigan

No bad intent intended.—Ed.

Blimps for Vietnam?

To the Editor:

It seems that there might be a use for "lighter than air" aircraft in the Vietnam war. A dirigible could function as a relatively stable observation platform above small arms fire. It might also serve for supplies or ammunition replenishment and perhaps medical care.

Paul C. Sackley
Valparaiso, Ind.

Lesson Lost

To the Editor:

With reference to your April 18 editorial, "The Lessons of Vietnam—Part IV," I contend that your rationale is nothing but a semantic swindle.

In your discourse on comparative ideologies, you present our philosophy as one geared to the protection of the minority. If this is so, why haven't we sent an expeditionary force to Rhodesia to "protect" the white minority there? They certainly are struggling for survival, and they certainly are a minority, so I believe they qualify for military assistance, don't you?

The one acceptable statement in this editorial I will add is the last one; namely, ("Last of a series").

Robert J. Temes
Sepulveda, Calif.

Oxygen Recovery

To the Editor:

The article "NASA Seeks Breakthrough in Oxygen Recovery Systems," by Heather M. David (M/R, April 4, p. 29) is a very timely item. I have felt for a long time that the U.S. has placed inadequate support in this area. The complexity of the problems is enormous, and the importance to *manned* spaceflight is paramount

Last December, a symposium was sponsored by the American Chemical Society (Atlantic City Meeting) on "Atmosphere in Space Cabins and Closed Environments," covering the up-to-date situation. This material is being published as a Symposium Volume by Appleton-Century-Crofts, and with the unusually good co-operation of the authors it is probable that the volume will be on the market the last week in May.

Karl Kammermeyer
Professor and Head
Dept. of Chemical Engineering
The University of Iowa
Iowa City

Report on Non-Profits

To the Editor:

I enjoyed reading your April 25 editorial ("A Sound Review"). After reading it, I re-read the article that appeared in the *Washington Post* on Sunday, April 17, on page A14—entitled "Fee Trim Ordered for AF Suppliers" and included in the "Around the Nation" section.

Any resemblance, other than the subject matter, between these two articles is purely coincidental. I have never read two articles that have been so different in their interpretation of a report.

I hope you will have a chance to read the *Post's* article and see for yourself what I mean. Personally, after reading your editorial, I was inclined to agree with your views and quotes from the report.

Please keep up your editorials. They are first class.

Malcolm C. Peplow
Washington, D.C.

Get Yourself a Gurkha

To the Editor:

Quick answer to Vietnam problem: Prevail upon Britain to lend a battalion of Gurkhas. Provided they have their knives, it doesn't make much difference how sophisticated their other equipment is. Ask the Germans; ask the Congolese rebels.

F. J. Robertson
Vancouver, Canada

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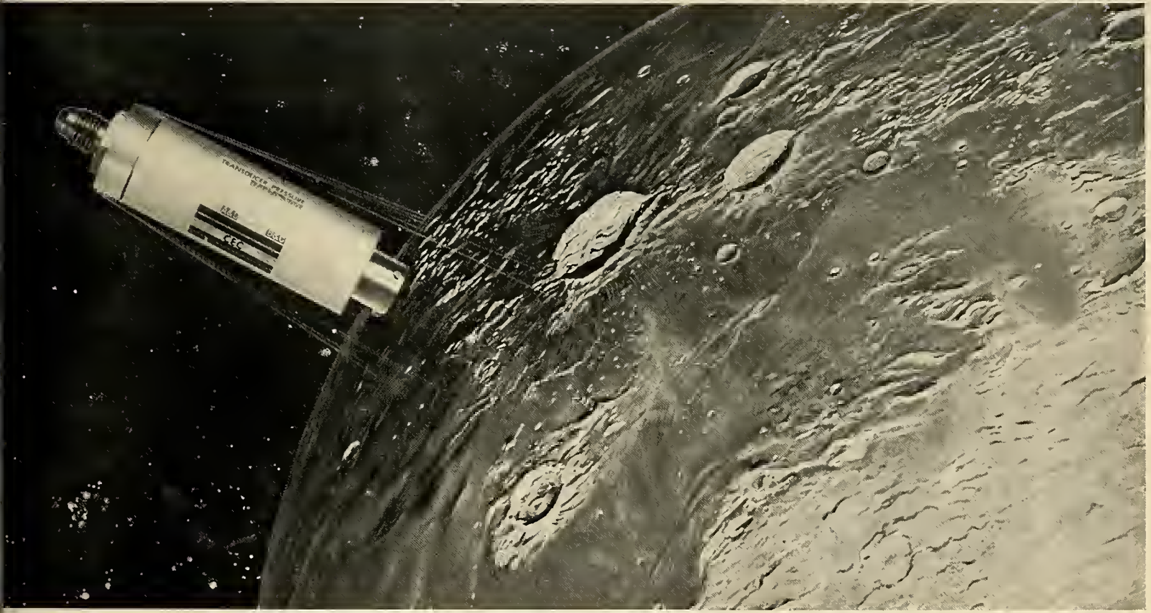

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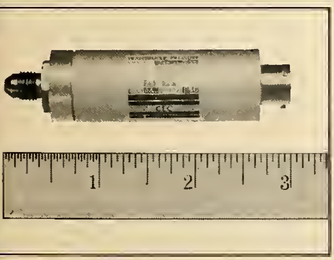

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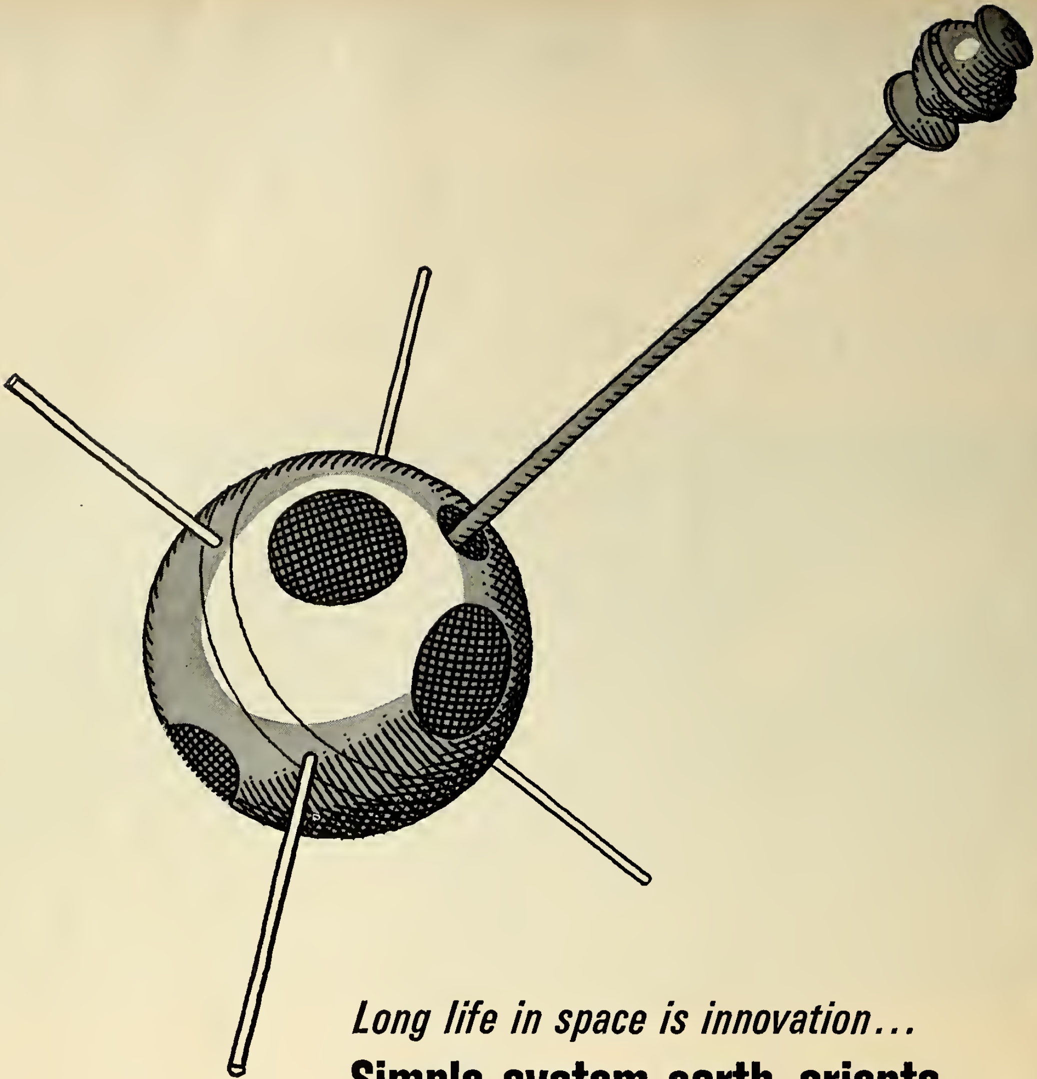

Long life in space is innovation...

Simple system earth-orients satellite for two years

The development of gravity gradient stabilization systems—unique in their mechanical operation and extreme simplicity—is the result of a major G-E program to attain long-life space systems. The success of this design innovation was proven when a system with only 15 parts successfully stabilized an operational satellite and met all design objectives in its initial launch. It is still operating effectively in orbit two years later. In all functions, at all levels, achieving long life in space is the ultimate goal of the . . .

MISSILE AND SPACE DIVISION

162-15

GENERAL ELECTRIC

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The Countdown

WASHINGTON

Phoenix Not Yet Out of the Ashes

Successful completion of the first powered flight of the Navy/Hughes *Phoenix* air-to-air missile at Pt. Mugu late last month has raised hopes that the trouble-plagued weapon is back on track. The missile was launched from an A3 test aircraft. First guided flights from the F-111B, for which the missile is designed, will not begin until early next year (M/R, April 18, p. 9). Despite the recent success, Navy and Congress both are far from overjoyed with the system. Reasons: the project has slipped 18 months, is $60 million over budget and still has some technical bugs. Chief of Naval Operations Adm. David L. McDonald told Congress flatly: "If the *Phoenix* missile does not work, we do not need the F-111B."

Poseidon Price Tag Put at $3.5 Billion

Secretary of Defense McNamara estimates that total cost of the *Poseidon* submarine-launched ballistic missile program will reach $3.5 billion, including $1.3 billion in development costs and in excess of $2 billion for production and retrofit of *Polaris*-carrying submarines. Navy reports operational availability date of the missile has been advanced.

AAP Systems Award Expected Soon

Announcement of two or more winning contractors for systems definition of the *Apollo* Applications Program is expected this week or next, after approval by NASA Administrator James E. Webb. Marshall Space Flight Center made its presentation to associate administrator for manned spaceflight Dr. George E. Mueller on May 4.

Sailors Get Redeyes

Navy officials are optimistic about eventual use of a seaborne version of the Army's shoulder-fired *Redeye* air defense missile system aboard very small craft otherwise unable to defend themselves against air attack. The system is not competitive with the *Sea Sparrow* weapon, which would require a larger ship to house and support it. Early feasibility tests at Pt. Mugu using small amphibious craft showed that acquisition and tracking could be accomplished from such a moving platform. Results were encouraging enough to signal a start of firing trials.

NASA Plans Fluidics Launch at Wallops

NASA will launch a sounding rocket from Wallops Island next month in its continuing tests of fluid dynamics under zero g. Vehicle will be a *WASP* sounding rocket.

Date Is Set for Surveyor Launch

Launch of the first *Surveyor* spacecraft is set for May 30 from Cape Kennedy. Go-ahead was given following a completely successful all-systems test of the spacecraft and its launch vehicle. A series of flight simulations will be run right up until launch day. Any technical hitches developing during these might, of course, force a delay.

Oceanography Bill Gets Support

Top figures in the oceanographic field—including Assistant Secretary of the Navy Robert W. Morse, Navy oceanographer Rear Adm. Odale Waters, Dean Athelstan Spilhaus and scientists from government agencies—told Congress a bill which would subsidize "sea grant colleges" in the same manner as land grant colleges would be of great benefit. Rep. Paul G. Rogers, a supporter of the bill which has been introduced into the Senate by Sen. Claiborne Pell (D-R.I.), warned that the race is as intense in oceanology as in space.

Budget Cut Forces Delta X-15 Delay

A one-year delay in development of the delta-wing *X-15* research aircraft is one result of the Johnson Administration's reduction of the requested NASA budget for FY '67 to $5.012 billion from the hoped-for $5.6 billion. Originally expected to fly in 1969, the aircraft's first flight now has been delayed until at least 1970.

Tests To Start on Apollo 008 Modules

Full-scale flight-ready Block I *Apollo 008* Command and Service modules, delivered this week to NASA's Manned Spacecraft Center in Houston, will begin a series of thermal vacuum tests inside MSC's big man-rated space environment chamber. Purpose is to evaluate and verify the complete spacecraft design in support of the first manned *Apollo* flight, which may come late this year. The manned chamber tests to start in mid-July will simulate launch, orbital phase, systems failures, emergencies, operations, module separation, re-entry separation and recovery aids checkout in a space environment that simulates all but zero gravity.

INDUSTRY

X-15 Hypersonic Ramjet Decision Due

Three firms—General Electric, Marquardt and Garrett Corp.—are awaiting recommendation of the source evaluation board on development of a hypersonic ramjet engine, expected in about two weeks. The engine eventually will be flown on the *X-15*.

Two Firms Named in Langley Computer Buy

Langley Research Center has selected International Business Machines Corp. and Control Data Corp. for competitive negotiations leading to a contract to furnish a large-scale digital computer complex for the center. Value of the computers is expected to reach $15 million. Contract will cover all of the center's computer needs for the next six years.

INTERNATIONAL

French May Up ELDO Share

Stresses within the European Launcher Development Organization may be resolved by an increase in French financial support in order to lighten the British share, which at present approaches 39%. This would alleviate the most serious immediate complaint but ELDO may still have to undergo radical changes before a satisfactory arrangement is achieved.

Japan Plans Second Space Center

Japan plans to build its second space center on a southern offshore island. The National Space Development Center, which hopes to orbit a multi-purpose satellite by 1970 (M/R, Dec. 20, p. 30), will build the center on Tanegashima Island, about 25 mi. off the southernmost main island of Kyushu. Immediate plans call for construction of a launch pad for liquid-fuel vehicles.

Domestic Comsats Discussed

Washington—August 1 has been set as target date for filing reply comments with the Federal Communications Commission on the American Broadcasting Co television distribution satellite application.

These will include a formal Communications Satellite Corp. proposal for development of a domestic television distribution satellite system, according to Comsat board chairman James McCormack.

Until that time, the former Air Force general stated, the affected common carriers, broadcast companies, and Comsat will attempt to narrow the present wide gap between Comsat and the other interested organizations on the technical approach, fundamental economics, and developmental time scale that now exists.

In its application to the FCC, McCormack disclosed, Comsat will provide a description of the overall TV distribution net with sufficient technical detail of the satellites, ground support terminals and probable vehicle and site locations to obtain at least tacit Government approval—sufficient to permit a start on ground station hardware development. Such equipment, he stressed, will be the constraining factor since development time will require at least three years and probably longer.

Speaking at a press conference prior to his luncheon address before the AIAA Communications Satellite Systems Conference here May 2-4, McCormack suggested that the domestic TV distribution system would require from two to four vehicles in synchronous orbit, supported by possibly 80 small stations ($100,000 each) for the principal TV market, 3 to 10 larger stations ($3 to $4 million each), and an undetermined number of van-type mobile units for news event coverage. (He also noted that Radio Corp. of America, in its study last year performed for NBC-Television, forecast a need for up to 500 ground stations.) Operational target date would be 1969 (M/R, April 18, p. 10).

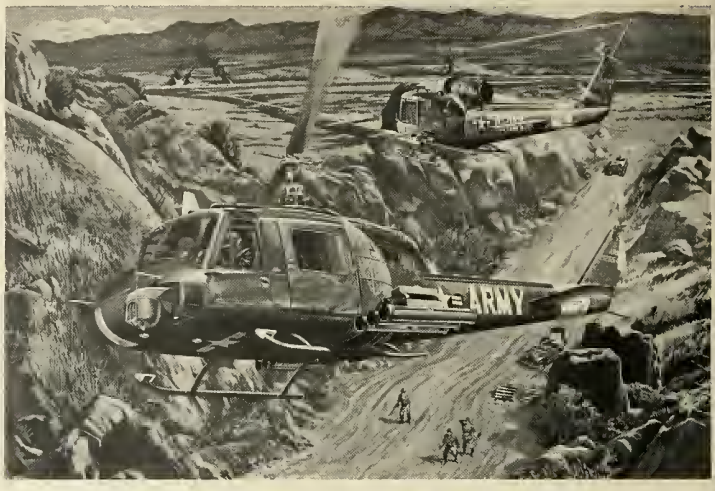
McCormack also stated that Comsat is:

—Still negotiating with the Dept. of Defense for use of leased surplus circuits on the Pacific *Apollo* comsat with pricing the present delaying problem. (Vehicle launch dates are Sept. 9 and 30.)

—Considering a second West Coast global Earth station, not necessarily at Brewster Flat, Wash. (the present site).

—Finalizing negotiations with American Telephone and Telegraph Co. for purchase of that firm's *Telstar* ground station at Andover, Maine, used with Comsat's *Early Bird*.

McCormack also disclosed to the press that the International Telecommunications Satellite Consortium (INTELSAT) soon expects to total 50 countries when the Philippines and Thailand sign up. He also indicated that preliminary discussions have been held with representatives of Yugoslavia concerning its possible inclusion as a member of the international consortium.



New Helicopter Sight Developed for TOW

Artist's concept shows the new gyro-stabilized gunsight, which will allow use of TOW antitank missiles aboard helicopters (M/R, Oct. 25, p. 14). It will enable gunners to hold aiming crosshairs on moving or stationary targets while the helicopter pilot is taking evasive action to avoid ground fire.

Foreign Research Cut Asked

A Congressional subcommittee has called for restrictions on the award of research contracts to foreign scientists in an effort to help stop the dollar drain.

Pointing out that such awards by five major agencies has increased from $24 million in FY 1962 to $27 million in FY 1966, the Subcommittee on Research and Technical Programs of the House Committee on Government Operations indicated that foreign scientists should get U.S. contracts only in special circumstances. The five agencies are NASA, the Atomic Energy Commission, National Science Foundation and the Depts. of Defense and Health, Education and Welfare.

The subcommittee recommended that the Bureau of the Budget issue a directive limiting foreign research expenditures to those urgently needed by the U.S. and which cannot be carried on here.

It also called for an investigation of overseas science offices maintained by U.S. agencies with a view to minimizing dollar costs of those offices through consolidation.

House Acts on NASA Funds

The House Independent Offices Subcommittee was expected to vote late last week on the FY 1967 NASA appropriations bill, despite the fact that the Senate has not yet acted upon the authorization.

The House cleared the $4,986,864,150 NASA bill for Senate action by a vote of 349 to 10 on May 3, after voting down several attempts by Republican Congressmen to cut the bill.

Four amendments defeated by voice vote were submitted by Rep. James Fulton (R-Pa.), who sought to cut the *Apollo* Applications Program, advanced missions, the lunar sample receiving laboratory and facility planning funds.

In explaining his objections to the lunar sample receiving laboratory which NASA plans to locate at Houston, Fulton said he found "charmingly innocent" the fact that five out of eight members of the site selection board were from Houston. Other Republicans protested from the floor what they termed a concentration of Government research facilities and contract awards to Texas.

Fulton also termed dangerous the plan by NASA to transport the first *Apollo* vehicle returning from the Moon, together with its astronauts and a sample of lunar soil, in one transport plane from the water recovery site across the ocean and part of the continent to Texas.

If it were to be lost, he noted, the entire proceeds of the first exploration of the Moon would be gone. A sample receiving laboratory as near the recovery site as possible would be much safer, he ventured.

SAC Gets Minuteman II

The first *Minuteman II* squadron has been turned over to the Strategic Air Command at Grand Forks AFB, N.D., beginning operational service of the advanced weapon system.

When completed, the SAC Wing 6 will have three squadrons, 150 missiles, in its *Minuteman* force. The advanced weapon will eventually replace *Minuteman I* missiles in all operational sites in the six *Minuteman* wings.

Shots of the Week

The first cooperative Brazilian-United States meteorological sounding rocket launch took place at Natal, Brazil, May 1.

The program seeks wind and temperature measurements and other data at altitudes between 25 and 60 miles by use of the acoustic grenade technique. Small acoustic grenades are ejected and detonated at regular intervals during ascent of the rocket.

- The first powered flight test of the *Phoenix* missile was conducted at the Pacific Missile Range late last month, Hughes Aircraft Co. has announced. The missile was fired from an A3A Skywarrior aircraft by Hughes under the direction of the U.S. Naval Missile Center. The operation proved the compatibility of the missile and the test aircraft.
- A single-stage *IT160-1* sounding rocket was successfully launched April 25 from the Kagoshima Space Center, Kyushu, Japan, to gather data on ion density in the upper atmosphere.

McDonnell Gets MOL Award

McDonnell Aircraft Corp. will test the *Gemini* heat shield for use on the *Manned Orbiting Laboratory* under a new $2,071,882 contract. The cost-plus-incentive-fee contract was awarded by Air Force Systems Command's Space Systems Div.

Engine Modified for S-IVB

Douglas Aircraft Co.'s Space Systems Center is modifying a small hydrogen-oxygen burning engine to serve as a heater for expanding the helium gas used in repressurizing the S-IVB propellant tank in space.

During lunar missions with the *Saturn V*, repressurization of the third stage tanks is essential prior to the restart of its main engine after a period of coasting in space. The current S-IVB repressurization system uses helium stored at normal temperatures.

The oxygen-hydrogen burner will make it possible to meet pressure requirements by using supercold helium from bottles immersed in liquid hydrogen at —423°F. This will also reduce the number of containers needed to house the helium, thus saving 800 lbs. in total weight of the S-IVB.

NASA Uprates J-2 Engine

Maximum thrust of the liquid hydrogen J-2 rocket engine has been increased by 5,000 lbs. to a total of 230,000 lbs.

The engine is used to power upper stages of the *Saturn IB* and *Saturn V* launch vehicles.

Marshall Space Flight Center said uprating of the J-2 was achieved by strengthening turbine wheels of both the liquid oxygen and liquid hydrogen turbo pumps and modifying the engine control system to maintain the engine's high operating reliability at maximum thrust.

The uprated engine will be started in flight at its upper thrust limit of 230,000 lbs., after which thrust can be reduced to 180,000 lbs. as propellant is depleted. Earlier J-2 engines operate over a thrust range of 225,000 lbs. to 175,000 lbs.

ARC Testing Solid Propellants

Atlantic Research Corp. has begun a series of tests of an air-augmented solid rocket propellant.

In the first test conducted recently, a 900°R airstream was used to simulate Mach 2.5 speeds. The test was run in a modified ramjet test facility with the firing conducted using developmental fuels.

Results have confirmed ability of the facility to provide an effective way to obtain data for fuel formulation optimization and rocket design, ARC said. The company will study effects of fuel formulation variables and motor parameters, as well as environmental tests of materials.

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BSEE-Reliability test engineering:
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BSME-Reliability and inspection:
Perform mechanical and structural reliability analyses. Provide for inspection planning and review prints to determine inspection attributes. Experience in metallurgy and NDT helpful.

Non-destructive testing:
Background in electronics and applied physics plus knowledge of instrumentation related to the use of X-rays, sound waves, electrical fields and optics.

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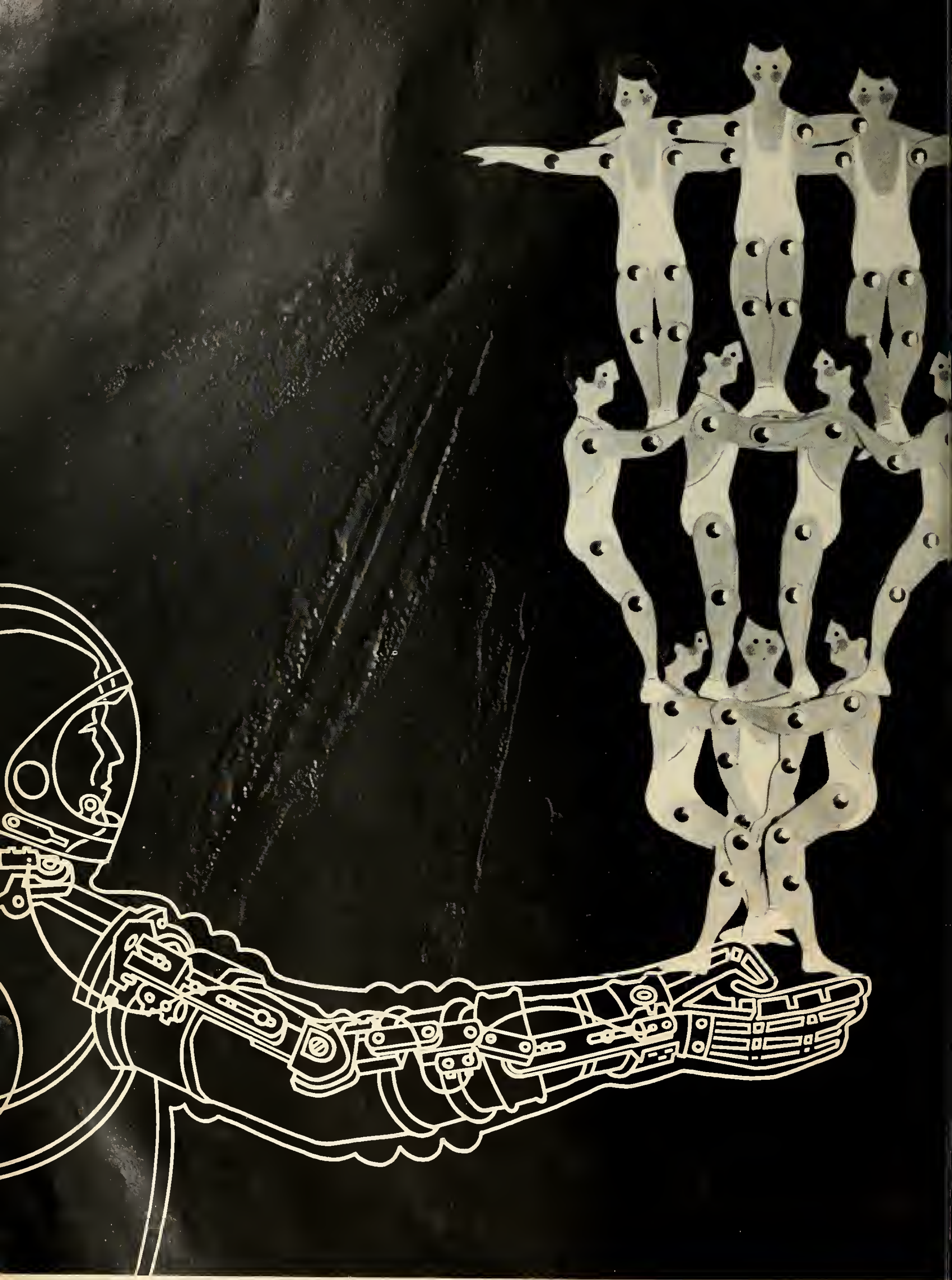

LIFT A TON WITH EITHER HAND?

It's simple if you're outfitted with a Man Amplifier, a framelike powered exoskeleton that fits the human form. Now under development, a Man Amplifier might well be powered by Kearfott actuators. One use foreseen for the system is to make it easy for astronauts to work in the vacuum of space.

Our rotary and linear actuators have already solved some of the most far-out problems in control system design.

ELECTROHYDRAULIC ACTUATORS. Kearfott Hydropacks were the first fully self-contained, modularized, plug-in hydraulic actuator systems to become standard hardware on an operational missile. These compact units are installed right where the muscle is needed and energized from the nearest electrical outlet. We supply six Hydropacks for each of the Army's Pershing missiles, and more than 360 of these units have flown without a reported failure. The same principle (a closed loop system with pump, sump and actuator) is being applied in the Navy's ASMS missile.

Kearfott makes other novel hydraulic actuators which are not self-contained. One is being used for radar platform stabilization in the RF4C. Another acts as the steering muscle in an LVH hydrofoil boat. Still another helps out in a helicopter flight control system. These actuators have a unique ball-socket design which eliminates misalignment and allows rigid mounting of the actuator.

ELECTROMECHANICAL ACTUATORS. These, too, are seeing service in a wide range of applications. A non-reversing actuator is used in the XC 142 to control pitch and trim of the horizontal tail surface. Another positions the tail prop. Both actuators operate during the transition from horizontal to vertical flight. Electromechanical actuators are functioning in the stability augmentation system of the CH46A Sea Knight helicopter, holding it steady even during a hasty unloading under combat conditions.

As for esoteric space applications—four Kearfott actuators were used on the Mariner 4 to control steering during its mid-course maneuver. Two others in the Apollo spacecraft transmit considerable torque through a hermetic seal, opening and closing the astro-sextant hatch and the crew hatch.

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Nike-X Deployment Feud Heightening

by Michael Getler

WASHINGTON—Continuing Congressional pressure for deployment of a *Nike-X* anti-ballistic missile (ABM) system in this country is causing a sharpening of positions on both sides of the question.

The House Armed Services Committee, in reporting out the Fiscal Year 1967 Dept. of Defense authorization bill last week, unanimously concurred in supporting the action of the Senate committee, which had added $167.9 million to the *Nike-X* budget the week before (M/R, May 2, p. 13).

Secretary of Defense Robert S. McNamara, who long has argued that an ABM system must be considered within the total context of damage limitation—including a fallout shelter program, improved bomber defenses, and other measures—told the House committee during hearings that "were the Congress willing to take all those actions, I would still recommend against the defensive systems, including *Nike-X*, at this time because I believe the Soviets could with relative ease and at low cost to themselves offset our defenses by strengthening their own strategic offensive forces."

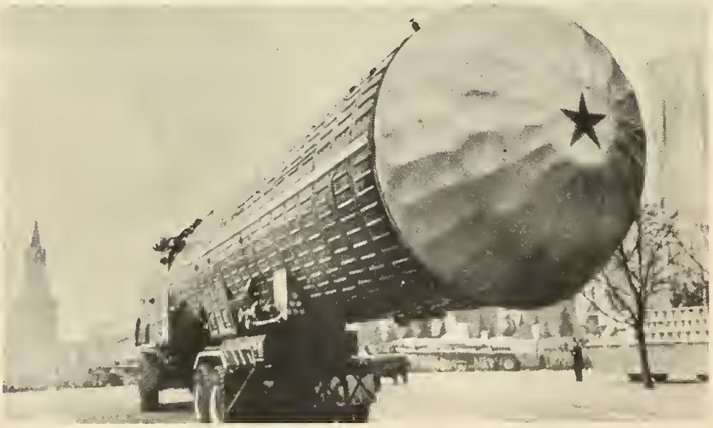
The Secretary told the Congress that the United States could offset any Soviet ABM system at a cost of between 10-20% of that system by improvements to the U.S. offensive force such as better penetration aids and the development of new, large, sophisticated-payload missiles.

The Secretary assumes that the Soviets would choose as the U.S. would to make that same relatively small expenditure (which could actually amount to in excess of $6 billion) in response to any U.S. ABM deployment.

"The savings in human life which would result from additional expenditures for strategic defensive forces," according to McNamara, "would be realized only if the Soviets did not react to our actions and attempt to offset them." Even if the Soviets did not react to a U.S. ABM with additional strategic forces, McNamara repeated, a Soviet first strike would cost more than 50 million lives.

The central arguments in the ABM debate have come to focus on two key points: what is the likelihood that the Soviets *will* react offensively to a U.S. ABM system?; and if they do not react, what is the potential for saving perhaps 50 million American lives in the event deterrence should fail—even though another 50 million may die?

Wheeler disagrees—The chairman of the Joint Chiefs of Staff, Army Gen. Earle G. Wheeler, has now openly challenged two of McNamara's assumptions related to these points.



Moscow Parade Shows Nothing New

Russians claim this missile, photographed in Moscow's May Day parade, is an anti-ballistic missile rocket capable of taking on incoming targets at long range. The Soviets, for the first time since May 1, 1963, failed to exhibit any new weapons. Observers felt they may be waiting for the 50th anniversary of the Bolshevik revolution in November, 1967.

Wheeler told Congress: "I do not know the level of damage which would destroy our Nation. I do not know whether this would be 10 million people killed in a few hours, 30 million, 60 or 70 million. I just do not know, and I do not believe anyone does.

"I do believe that the chances for survival of the Nation, however—and of an appropriate percentage of industry—would be far greater with 40, 60, or 70 million fewer fatalities than would be the case if we do not have a fallout shelter program and an anti-ballistic missile system."

Wheeler also said that while he agreed that offensive forces are cheaper than strategic defensive forces, "we are certainly in a better position than are the Soviets to devote resources to this purpose—and I am not talking of money only but also of the technical talent and the industrial back-up needed to produce these things. The Soviets are already heavily committed."

Wheeler, backed by opinion of the other chiefs of staff, said that "on balance, I find myself strongly in favor of a realistic ABM defense system . . ." Wheeler favors definite ties to the fallout shelter program but has also questioned the need for McNamara's lumping of new bomber defenses and other *SAM-D*-type missile defenses as part of the total package to be considered.

McNamara has tagged the *Nike-X* cost at about $20 billion, the fallout shelter program at $5 billion, the F-12 interceptor program at about $6.5 billion, and the cost of the *SAM-D's* at $2-3 billion.

Is it worth it?—The cost burden question, at least on the surface, is not the major stumbling block. Secretary McNamara, Air Force Secretary Harold Brown, and the Joint Chiefs all agree that the U.S. could support an annual expenditure of between $1-5 billion a year for about 10 years, which covers the gamut of damage-limiting postures under consideration. The question is: Are we wasting the money?

Alluding to the uncertainty of a thermonuclear-war sequence of events, Brown said: "The probability of all this happening at all is rather low, and the value of reducing U.S. casualties from 120 million to 60 million is, in the minds of many people, including myself, somewhat questionable. The argument is not that we cannot afford it—there is no question in my mind that the U.S. can—but that having spent this money we may not be able to change our policies in any particular way. It may not add to deterrence. It may not make it easier for us to exercise our power anywhere else in the world. . . ."

Pro-Nike—"The argument for the ABM is obvious," Brown continued. "If the war does happen, it is worth quite a lot to reduce casualties from 120 million to 60 million. It could also add to deterrence, though I don't particularly believe in that argument."

Air Force Chief of Staff Gen. John P. McConnell told the committee: "In my mind, there is quite a difference between the loss of 100 million and 60 million Americans. I think we ought to have this system." ■

DOD's Nike-X Planning Still Aimed at Chinese

WASHINGTON—The current debate in Congress over the Nike-X system tends to focus primarily upon its usefulness in the face of an all-out Soviet nuclear attack should deterrence break down completely. However, attention at the highest levels of the Defense Department continues to be focused on a system that would protect against a developing Chinese threat (M/R, April 11, p. 12).

There are several modes of deployment now under consideration. These breakdown into three very broad categories, according to defense officials.

One involves a relatively thin area defense that would protect the entire country against threats posed by the Chinese Communists, or nations other than the USSR. This type of system is less expensive than those now being mentioned in Congressional debate, believed to be on the order of $4-6 billion. It is also the one now getting the most attention.

A middle-of-the-road system, which could cost roughly $8-11 billion, would provide defense against the Chinese threat, some defense against a Soviet threat, and could serve as a building block for a future system to counter a large-scale Soviet attack.

The third general category is that associated with full-scale deployment against the Soviet Union. Such a system would cost $20-30 billion.

First Manned MOL Flight May Slip Into Early 1970

WASHINGTON—Addition of $80 million to the Air Force's Fiscal Year 1967 budget request is aimed at preventing slippage of the first manned flight in the *Manned Orbiting Laboratory* program into 1970.

The additional funds for the program were voted by the House Armed Services Committee last week.

Clear indication of a further *MOL* slippage unless more funds are made available by mid-summer was given by Air Force Secretary Dr. Harold Brown in testimony before the committee. The testimony was made public last week.

The *MOL* development and flight test schedule has already slipped nine months (M/R, April 18, p. 14) behind the timetable laid out for the program last year.

Request slashed—Brown reported before the committtee, that the Air Force had originally asked Secretary of Defense Robert S. McNamara for $395 million for *MOL* in FY '67, but that this figure had been cut by McNamara to $159 million ($150 million for RDT&E and $9 million in military construction allotments).

Brown admitted that after the original request for just under $400 million, a re-examination of the *MOL* schedule—taking into account the nine-month slippage and approximately $40 million carried over from FY '66—revealed a need of $230 to 240 million for FY '67.

"That is what I finally asked the Secretary of Defense for," Brown told the committtee. "We received $150 million. We were told that if we asked for $395 million first and then could only justify $230 million we could not calculate very well. That is a justified criticism, but I believe our calculation of $230-240 million is correct, and I am quite sure that we can obligate justifiably and profitably that much money in FY '67. That amount is necessary to keep the program on schedule."

Reprogramming possible—Brown reported McNamara as indicating that "if we still believed the $240-million figure and could prove it next July, he would let us reprogram the money.

"I don't know where we will reprogram the money from," Brown quickly added. "I don't think we have it."

A spokesman for the Armed Services Committee told MISSILES AND ROCKETS that the committee's action seeks to ensure that those funds are in the Air Force budget from the start and are clearly earmarked for *MOL*. He stated that the add-on was also intended to emphasize the committee's support for the *MOL* program.

During the hearings, Brown told the committee that the best current estimate "is that the first manned *MOL* flight will not occur prior to mid-1969, which is a slip of about nine months from what we stated last year.

"Without the additional money," Brown said, "I am sure there will be additional slippage. Whether it is six months or what, I cannot say." Brown did say that no specific schedule delay could be related to the funding cut in FY '67 until later this month, when the Air Force completes its evaluations of the *MOL* contractors' cost submissions.

Brown also said that the additional funds would provide reasonable assurance that a laboratory vehicle qualification test could be made in mid-1969.

Cost estimates from each of the *MOL* contractors were due at Air Force *MOL* headquarters early this month.

McNamara's justification—Earlier in the hearings, Secretary McNamara responded to Congressional questioning on *MOL*.

"Are there grounds for serious concern about progress?" asked Congressman Robert L. F. Sikes (D-Fla). "Time is passing and we have not pushed this program very rapidly, if it is contrasted with space progress generally."

McNamara pointed to the large carryover of unspent FY '66 *MOL* funds and said "this simply illustrates that fact we overestimated the rate of technical progress . . . and asked for more than we needed. I wanted to avoid this mistake twice. That is why I cut back the FY '67 request," the Secretary stated, "not because of any shortage of funds." This conflicts with Brown's later statement that the program would slip unless more funds are forthcoming by mid-summer.

"I think the Defense Department has, on many occasions in the past two decades, expended funds faster than was justified by technical progress," he added.

Specifically, McNamara pointed to the costly failures associated with the now cancelled Sugar Grove radio telescope project, which cost $70 million, and the *Dynasoar* project, which cost some $400 million before its cancellation in December, 1963. ■

House Group Force-Feeds DOD Budget

by Heather M. David

Washington—The House Armed Services Committee has voted to accelerate the *Condor* missile program by adding to the Dept. of Defense authorization bill funds not requested by the Secretary of Defense.

The committee, which is chaired by Rep. Mendel Rivers (D-S.C.), voted to add $26.6 million to the Navy RDT&E request for the *Condor.* The move was reportedly made to ensure the support of the program. The group also added $8.6 million to the Deep Submergence program.

Total additions to the authorization bill, which was passed by the Senate last week at $17.17 billion, would bring the House version to $17,858,059,000, which is $931.1 million more than the Administration request. The Senate voted to add only $243.1 million. Rivers also indicated the committee's intention to bring to a head conflicts with Secretary Robert S. McNamara over spending of extra monies voted by Congress for specific projects such as nuclear frigates, and over the cancellation of weapons systems without notifying Congress.

Thou shalt—On the former, Rivers said the bill will contain language saying "notwithstanding the provisions of any other law, the Secretary of Defense and the Secretary of the Navy *shall* (M/R's italics) proceed with the design, engineering and construction of the two nuclear-powered guided missile frigates as soon as practicable."

The committee added $127.8 million in FY 1967 money for one nuclear frigate, and $130.5 million for a frigate for which they had previously voted funds (never spent) in FY 1966.

"We are determined—and we are unanimous in our determination—that this country will have a nuclear Navy," Rivers said. "The Dept. of Defense has shown a strange, and to me unexplainable, resistance to nuclear power for our surface ships. This bill represents the turning point."

The language of the bill, with the word "shall," marks the first time the Armed Services Committee has translated its strong feelings into actual legislation on the spending of extra monies. A previous attempt along the same line concerning the RS-70 bomber was retreated from in the face of a Presidential showdown. Rivers indicated he will carry the action further this time.

Yet another manifestation of the committee's desire to gain some semblance of control over the Secretary's actions is a clause which would amend the National Security Act to prohibit the Secretary from substantially reducing or eliminating a major weapons system until he has reported all of the facts to the Congress.

All actions by the committee will be subject to House floor vote, expected sometime next week.

Other additions—The House committee also has voted $153.5 million for *Nike-X* preproduction activities, and $14.4 million for *Nike-X* research, development, test and evaluation (RDT-&E) activities—as did the Senate.

The committee likewise went along with the Senate in adding $55 million for six F-12 aircraft and $19.9 million for additional Light Observation Helicopters. Other House committee additions in the aircraft category include $20 million for television broadcast aircraft (TV/AC), and $51.2 million for 13 CX-2 medical evacuation aircraft.

An addition of $80 million for the *Manned Orbiting Laboratory* (see p. 13) brought totals for that fund to $230 million. The House committee also voted $11.8 million for the Advanced Manned Strategic Aircraft, bringing AMSA funds in the FY '67 budget to $22.8 million.

The addition of these funds, Rivers said, would bring AMSA to the program definition phase, since it would provide for work on the powerplant, avionics systems and configuration.

Other items in the total of $167.7 million added for Air Force RDT&E include funds for the F-111A, and V/STOL aircraft engine technology. Some R&D for Southeast Asia is also added.

In addition to the $26.6 million added to Navy RDT&E for *Condor,* and $8.6 million for the Deep Submergence program, the committee has recommended other classified items for a total of $142.7 million in additional funds.

MAW addition—Army RDT&E additions, along with the $14.4 million for *Nike-X,* include funds for the Advanced Aerial Fire Support System (AAFSS) and *MAW* antitank weapon.

Rivers said that the additions to the RDT&E portion of the bill "have a particular significance when it is taken into consideration that the Secretary of Defense refused $791 million requested by the military departments for this important activity."

The committee restored about $273 million of the reductions, Rivers said, on the basis of very detailed reviews of the final pleas made by the military departments to McNamara for restoration.

An additional $100 million of the extra money is for new requirements "clearly needed" by the military departments but not specifically identified until after the submission of the Defense budget to Congress. ■

Committee Urges NERVA Lunar Project

Washington—The Joint (Congressional) Committee on Atomic Energy has recommended that NASA and the Atomic Energy Commission cooperate in a plan to use the *NERVA* nuclear rocket engine in a lunar exploration program as an interim step toward the more advanced interplanetary missions for which nuclear energy is essential.

Such an assignment, the JCAE said, would assist in the direction of effort and be of value to lunar exploration.

The committee also noted that delays have occurred in satellite and small power sources (SNAP) systems, due to disagreements over use of technical data and protection of proprietary rights.

Without detailing these disagreements, the committee called for special efforts on the parts of contractors involved to recoup time lost. The disclosure was carried in a report on the Fiscal Year 1967 AEC authorization bill, in which the committee approved the requested space power and rocket propulsion budgets.

The JCAE also exhorted the Division of Space Nuclear Systems and the Division of Isotopes Development at AEC to give full support to the SNAP 27 and SNAP 29 programs. It said it was encouraged by recent indications that user agencies are showing increased interest in radioisotope SNAP devices for space.

A total of $45.3 million is included in the bill for satellite and small power sources, and $79.1 million for Project *Rover* and nuclear propulsion.

Total AEC bill recommended by the committee is $2,259,958,000, a reduction of approximately $15 million from the requested amount.

Slight Fund Hike Predicted for Solids

Aerojet's Richard Cottrell

WASHINGTON—The solid propulsion industry is running at about 60% of the funding level reached in the early 1960's —and it should stay the same or rise slightly over the next two years.

Richard F. Cottrell, manager of Aerojet-General Corp.'s Solid Rocket Operations, Sacramento, Calif., told MISSILES AND ROCKETS that there will be either drop-outs or mergers in the ndustry as competition for new business becomes more dependent on price han on technology.

Other points covered by the solid propulsion expert included:

—Claims that the 120-in. solid motor can handle most foreseeable missions are narrow and incorrect.

—Hybrid engines in the station-keeping, orbit-changing and re-entry maneuvering classes should be developed rather than large thrust devices.

—It is clear the Air Force will initiate a program to develop a vastly improved ICBM within three years. Cottrell says it is not likely any liquid stagng will be involved.

—Propulsion research is not being constrained by funding. The Aerojet executive does not know of any crisis in propulsion because of R&D dollar limits.

—Solids will gradually take over first-stage propulsion throughout the chemical propulsion field.

—The next major 120-in. buy will be competitive.

Possible fund impetus—A major surge in solids funding would result from a decision to develop a large solid first stage for a launch vehicle or from an acceleration of the Air Force *Manned Orbiting Laboratory* program. Cottrell also noted that any deployment of an A-ICBM would have the same effect.

Cottrell took issue with statements made by Barnet R. Adelman, president of United Technology Center (M/R, April 18, p. 22) on the future applications of the 120-in. solid. The Aerojet official says any new vehicle should be designed from the ground up, taking full advantage of the demonstrated ability of solids up to and including the 260-in.-dia. class. "One hundred twenty inches is not a magic number," he says. "You can go to 180, 200 or even 300 in. in diameter." The choice should be made from a spectrum of requirements.

The prime advantage of solids is simplicity, and clustering is neither simple nor clean. "For example," says Cottrell, "the *Saturn IB* can be uprated by adding 120-in. solid units, but this approach is not efficient from either the dollar or performance viewpoints over a 260-in. stage.

"If and when NASA embarks on a new vehicle beyond the *Saturn V*, the first stage will be solid," he says. "Any new vehicle designed to handle the payload gap between *Saturn IB* and *Saturn V* will also have a solid first stage."

Cottrell says mission studies covering *Voyager*, space rescue, manned orbital research labs and manned astronomical labs may provide the impetus needed for the development of such an in-between launch system.

Hybrids out—Cottrell sees no requirement for a hybrid first stage. "If there is an error in current hybrid development, then it is an error in size." What is really needed is a small, efficient hybrid engine family designed to handle space control and maneuvering functions, he says. No vehicle is now booster-limited.

Cottrell says it will take some time for hybrids to develop good fuel efficiencies. Combustion efficiency will be compromised in any early attempt to scale up to booster sizes. He categorizes present hybrid development as a "step in the direction of getting ahead of yourself."

Cottrell says the Air Force is considering opening the next 120-in. *Titan III* procurement buy to all comers. This would be a production program reaching the $350 million level at today's prices. The main reason for the proposed competition would be to lower cost per unit. Competitive bidding usually does this.

Future business—Price will be the key to the future solid propulsion market. Cottrell says the technical competence in the industry is fairly equal and the firms able to apply maximum talent and lowest possible costs on proposals will collar the business. Some firms with low sales volume may be forced to quit. Others may have to merge to effectively compete.

New propulsion systems are few and far between, forcing all the firms to compete for every contract. Cottrell finds it hard to see how the smaller companies can provide the customer as much for his dollar as the larger firms.

A prime example of the trend is the *Short-Range Attack Missile (SRAM)* propulsion competition. Pulse technology probably will be involved, but it will be won on costs.

Big solids—Aerojet expects to test fire its third half-length 260-in. solid motor in April, 1967, and Cottrell expects that a fourth firing would go to a full-length motor.

The House Space Committee increased NASA's $3.5 million large solid request to $11 million. If this total amount is authorized, Cottrell says, some $6 million could be saved by initiating the full-scale motor effort next fall in parallel with the current half-length project instead of any sequential programming.

Next April's firing will use a full-scale nozzle. A contractor was expected to be chosen late last week. Rohr Corp. and TRW Electromechanical Div. are competing.

The nozzle will be submerged to the extent necessary to allow omni-axis gimballing. Some submergence is necessary for this approach, while liquid thrust vector control can be used whether or not the nozzle is buried.

Cottrell says omni-axis gimballing is the most efficient TVC approach and will probably be adopted for large solids. If time were a limiting factor, a flying 260-in. would use liquid TVC. The omni-axis approach allows a total latitude of mission and trajectory choices while liquid TVC has to be tailored for specific missions.

Hot-gas concepts, while more efficient than liquids, still pose plumbing problems and Cottrell says ram air injection is unlikely because of the valve sizes needed to handle the volume of air.

Another TVC approach might involve upper-stage or "front-end" steering for large vehicles. The first and second stages would have no control systems. All such functions would be handled by some auxiliary system far up on the nose. ■

U.S. Now Has Dimming Hopes For Space Pact with Europe

by Hal Taylor

WASHINGTON—Administration officials are currently pessimistic about the chances for a major new space cooperation project with European countries.

As a result, it is believed that NASA Administrator James E. Webb's trip to Europe to explore the possibilities of such cooperation will not be made as soon as some U.S. officials had hoped.

The pessimism stems from the indications that the Europeans are far more eager to go ahead with their own space plans than they are to join this country in cooperative efforts.

As an example, they cited France's reported plan to join the Soviet Union in establishing a world-wide communications system. Another is Britain's threat to withdraw from the European Launcher Development Organization, apparently because the British feel they can't afford the cost (M/R, May 2, p. 24).

As one official pointed out, if Britain feels it can't afford ELDO, it is unlikely it will want to spend larger sums for new cooperative projects.

President Lyndon B. Johnson had told West German Chancellor Ludwig Erhard late last year that he would welcome U.S. and West European cooperation on a major new space program so that the Europeans could share in the technological breakthroughs of the space age.

He promised to send Webb to Europe early in 1966 to discuss the program with appropriate officials of Britain, France, West Germany and Italy.

Frustration—Later, a team composed of Dr. Homer E. Newell, associate administrator for Space Sciences and Applications; Dr. George E. Mueller, associate administrator for Manned Spaceflight; and Arnold Frutkin, assistant administrator for International Programs, visited several European countries to sound out their position on the project.

They returned with the verdict that it would not be appropriate for Webb to make a follow-up trip at that time—primarily because the Europeans did not know what they wanted to do.

NASA officials first said that Webb would go to Europe in the spring of this year; later, they amended this by stating he would wait until the NASA FY '67 budget had been approved by Congress.

The Webb trip still had not been scheduled as late as April 29, when a meeting of the National Aeronautics and Space Council was held. In fact, informed sources reported that the estimate as to when Webb would make the trip was not very soon.

The Europeans still have not indicated any interest in taking up President Johnson's offer.

NASA has no plans at this time to send another official delegation to sound out the Europeans. Apparently, the matter is being left to unofficial discussions between U.S. State Department officials overseas and the Europeans.

One possible other forum for discussions will be the Committee on Space Research (COSPAR) meeting which will be held in Vienna, Austria, from May 9 to 19. This meeting is attended by top-level U.S. and European scientists as well as scientists from other parts of the world.

Reach exceeding grasp?—The ambitiousness of Europe's plans for its own space program is illustrated by the current disagreement between participants in ELDO.

Britain, which pays nearly 39% of ELDO costs, reportedly wants to reduce its share of the expenses of the *Europa I* launch vehicle development because an estimated $220-million increase in the cost will go for non-British parts.

Europa I is composed of the British *Blue Streak*, France's *Coralie*, and an unnamed German third stage.

The British feel that the launch vehicle does not have the payload capability to add significantly to European space research or to place communication satellites into high orbits.

This addiction to communication satellites does not jibe with the U.S. hope that the Europeans will join with this country's Comsat Corp. to provide a world-wide communication satellite network. In addition, France has hinted she may join the Soviet Union in developing a Comsat system.

Webb's view—Administrator Webb recently told the House Independent Offices Subcommittee of U.S. hopes for further cooperation with the West Europeans.

The testimony, presented in late February and early in April, was released late last week.

Webb said the U.S. plan called for the spending by the West European countries of more than $150 million. He said France did not necessarily have to be included.

Webb stated: "If it is possible to get a concert of policies among most of those in European research organizations, or even a unit of them, a unit of several nations which might or might not include France, it would seem to us that they could undertake a project on the order of $100 million to $150 million in cost which might be a large spacecraft to go to Jupiter, or a large spacecraft to make investigations of the Earth-Sun relationships, and that we would launch this. Their funds would go largely to their own scientists and industry, with part of the funds purchasing a relationship with American industry in those fields where they can gain from working with American industry. . . .

"The general view of those concerned with the future of our relationship with Western Europe runs to the fact that 200 million people there need very much to bring the scientists in their universities, their engineering education and practice, their industrial know-how, into some system that gives them a very positive objective and which generates all of the technologies which will permit them to make their own decisions as to the future and not be complete prisoners of other nations with respect to what you can and cannot do with technology." ■

Burroughs To Expand BUIC Role

Burroughs Corp. has been awarded a $14,050,000 contract from Air Force to expand capabilities of BUIC (Back Up Interceptor Control) System for SAGE air defense. Shown is TV-type display console used to spot and track targets.

New Funds To Maintain Saturn IB Line

New Orleans—NASA plans to continue *Saturn IB* production with new funding of $41 million.

Fiscal Year 1967 funds will be used to insure that the production line for the launch vehicle's stages and engines is maintained past the late-1966 cutoff for Project *Apollo* production.

Inclusion of the funds in next year's budget was revealed by the publication of closed hearings held on the space agency's funding request by the House Independent Offices Subcommittee.

The funding has already been approved by the House of Representatives. Approval of the Senate is considered certain and NASA is expected to get a go-ahead for its plans within the next four to six weeks.

In discussing the plan, Deputy Administrator Dr. Robert C. Seamans told the subcommittee that "We do have in this budget here under the *Apollo* item, $41.9 million in 1967 for follow-on hardware. If we do not have it in 1967, then we have to start shutting down the production lines that are making the *Saturn IB*. In particular, we have to shut down production of the engines, the H-1 engine. So, to keep the option of the follow-on, we are requesting $41.9 million in 1967."

Chrysler concern—The plan was revealed as an industry official said Chrysler Corporation's Space Division will have to get add-on contracts in its *Saturn IB* program or staff cutbacks loom at the end of this year.

H. D. Lowrey, president of the division, told a press briefing May 3 that the $360-million *SIB* contract held by the company is due to expire in mid-1968. He said the Government has indicated an interest in continuing the production of the *Saturn IB* past that point, but that so far there has been no definite action.

The firm hopes for a follow-on contract by the end of this year for 16 more vehicles.

The hoped-for follow-on order would keep the Chrysler space people busy for three to four more years, Lowrey said. Cost of each follow-on vehicle produced would be reduced 30-40% from first production runs. But he gave no first-run comparative cost figures.

Chrysler, with the blessing of NASA, has assembled a wide range of uses for the *IB*, once its role as flying lab for *Saturn-Apollo* components is finished. Onc prime mission envisioned by the company is a vehicle which would be ready within hours to perform emergency orbital rescue missions.

"It is Chrysler's belief," Lowrey said, "that large orbiting space stations will be the next major space venture . . ." and he emphasized ". . . that the *Saturn IB* has a capability of putting at least 40,000 pounds of payload into Earth orbit. . ."

The firm has checked some 70 methods for uprating or improving the *Saturn IB* payload capabilities, including work with United Technology Center's 020 solid motors using four 5-segment strap-ons which boost the load capacity of the *IB* to some 78,000 lbs. The use of 7-segment strap-ons is also being studied. ■

Gemini 8 Thruster Failure Electrical

Houston—Post-flight analysis, including an engineering autopsy on the re-entry module, has not pinpointed the exact cause of the runaway thruster that abruptly terminated the *Gemini 8* mission on March 16.

However, *Gemini* program officials at NASA's Manned Spacecraft Center here are content in having isolated the probable cause of the problem to several spacecraft components and indicated last week that corrective action will affect all these components on *Gemini 9* and later spacecraft.

Charles W. Mathews, *Gemini* program manager, emphasized that the faulty thruster with its associated hardware and electronics was contained in the adapter module that the crew abandoned in orbit prior to their re-entry.

"If we can believe telemetry data, we can isolate the cause of the problem to either spacecraft wiring or thruster valve solenoids," Mathews said. Specifically "where" in the wiring or valve solenoids was difficult to determine without testing the actual equipment, he explained.

Mathews said the failure had to be electrical, since two separate solenoid valves were simultaneously energized into releasing fuel and oxidizer that, when explosively combined, produced a "hard on" thruster condition.

Fortunately, he said, that part of the spacecraft was heavily instrumented and this enabled engineers to narrow the probable cause to a "certain section of spacecraft wiring from the telemetry pickup down to the thruster solenoids."

Six suspects—In making the analysis, however, engineers took into consideration the possibility that telemetry data could be wrong. "The failure had to be in a local area to supply power to the solenoid valves," Mathews said. The most probable location was between the source of power (control bus) and thruster operation and control electronics contained in the orbital attitude maneuvering electronics box.

Considering all possible shorts, six components were suspect: a diode, a relay armature, the last transistor in the valve drivers (switching devices), the telemetry pickup, spacecraft wiring, and valve solenoids.

Mathews said components taken from the same lots as those used in the *Gemini 8* spacecraft were tested, dissected and inspected. The history of each component was traced through test data, discrepancy reports and material review records. Each component underwent a design review.

"We found no evidence of failure," he said. To avoid the possibility of a loose, metallic substance initiating a short within the box, the interior of the container was coated with a special material.

Instrumentation as the cause was "ruled out," he said, explaining that the system is protected by a high-level resistor that keeps the current from opening the solenoid.

In spacecraft wiring, engineers took some of the "sharp bends" from clamped wire bundles within the spacecraft structure, reduced the number of insulation wrappers in some areas to make wires more flexible, and re-inspected clamps for proper fit over wire bundles.

The valve solenoids were inspected and their design reviewed. "The solenoids looked extremely good. We couldn't improve upon them," Mathews said. ■

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Pan Am To Use Voice/Data Compression

A form of transmission compression will be employed in a new Automatic Alternate Voice/Data System developed for Pan American World Airways by ITT World Communications. The system, through use of a magnetic drum storage unit, detects normal pauses or breaks during voice transmission and fills them in with other operational data. The voice transmission, although slightly delayed, has priority, but during pauses in conversation, short data bursts are introduced at rates of up to 2,000 bits/sec. (or 4,000 words/minute). The approach may have far-reaching effects in the field of telecommunications for improving channel utilization since studies have shown that average two-way voice transmissions occupy only 36% of total circuit capacity, ITT officials said.

Bell Aero Visual Simulator in Operation

Three dimension projections on a 10 x 14 ft. screen are used in Bell Aerosystems Co.'s new Visual Simulation Lab, Buffalo, N.Y., which went into operation for the first time last week. The simulation complex, capable of use for both space and Earth environment pilot training, includes a 3-D lunar terrain model, closed-circuit TV, vehicle models, changeable cockpits and controls, an electronic image generator, planetarium and supporting analog and digital computers. Studies to be performed initially are associated with NASA's manned space flight efforts. One involves use of a self-propelled remote space maneuvering unit that might be directed from a mother spacecraft in orbit for rescue, inspection of other vehicles or as a shuttle vehicle. Another study will be concerned with a manned lunar-exploration flying vehicle.

Highly Flexible Radiometer Developed

An extremely versatile infrared-scanning radiometer, developed by GCA Corp. for the Army's *Nike-X* project office, is capable of measuring energy varying in intensity from those as low as lunar emissions to solar radiations. Designed to support advanced research efforts for the anti-ICBM program, the instrument will be employed in a variety of efforts including the study of rocket plumes and above-atmosphere explosions. Providing a 40 x 40-milliradian field of view, the instrument performs measurements over the spectral range from 0.5 to 3.5 microns using 20 lead-sulfide IR detector cells. Arranged in a vertical array, the cells are scanned through the horizontal field of view by means of a nutating mirror assembly sweeping at a rate of 24 frames/sec. Intensity is regulated by a variable iris controlling the input energy.

FLUIDICS

Military R&D Yields New Industrial Control

An all-fluidic control system has been developed by Honeywell, Inc., to direct start-up, operation, and shutdown of engines and compressors used in natural-gas pipelines. A direct outgrowth of the firm's R&D program to produce fluidic control systems for Air Force jet engines and missiles, the industrial system performs all necessary sensing, logic, power amplification, and control functions with non-moving, non-electrical components. Even the system indicators are operated fluidically, developers said. A prototype was first shown publicly at the recent Petroleum Industry Electrical/Electric Supply Association's show in Tulsa, Okla. The system has been field tested for more than 9,000 hours without problems in a temperature range varying from —20° to 120°F. The fluidic indicators, developers said, have been operated reliably throughout more than 20 million cycles. Honeywell declined to reveal the organization purchasing the first production system.

PROPULSION

Operation Gunfighter Initiated

Exploratory research at the Naval Propellant Plant, Indianhead, Md., involving the Army's High Altitude Rocket Probe (HARP) concept will lead to a series of accuracy tests on gun launchings at the White Sands Proving Grounds during May and June. The propellant program—dubbed Operation Gunfighter—is designed to explore propellant modifications to fit the Navy's 6-in./47 mount and a 5-in./70 barrel. Initial tests will involve firing non-rocket assisted projectiles to distances 40 to 50 miles across the desert. These ranges represent significant increases over current guns in use.

LIFE SUPPORT

Apollo Impacts Withstood

A series of 288 human impact tests carried out by the biodynamics branch at the Aeromedical Research Laboratory, Holloman AFB, N.M., has indicated that astronauts will be able to withstand certain predicted *Apollo* landing impact forces in different body orientations without significant incapacitation or undue pain. However, the impact forces, generated on the Daisy Decelerator, produced effects to the nervous, cardiorespiratory and musculoskeletal systems, including shortness of breath and chest pain, spasms and soreness of neck and back muscles and transitory stunning and disorientation. The work was done by the Air Force for NASA's Crew Systems Div.

Poor Man's Space Suit Possible for Tests

The Navy's Mark IV pressure suit, pressurized at 2.0 psig, can be substituted for the *Gemini* 3C-8 suit at 3.5 psig for research projects involving psychomotor skills such as manual dexterity, dexterity with tools, speed of arm movement, gripping strength, pursuit tracking, and static and dynamic steadiness, an LTV Astronautics Div. study indicates. After extensive comparisons with each, R. D. Hughingson concludes that there is no significant difference between the suits, although the performance differences in each suit attributable to the pressurized or unpressurized condition were marked. This finding could relieve the demand for *Gemini* and *Apollo* suits for ground-based research, he says.

Sulfuric Acid Electrolysis Cell Seen Promising

The power needed to generate two pounds of oxygen per day—one man's requirement—from water vapor by a matrix of sulfuric acid and silica gel electrolysis cell is only 279 watts, two Ames Research Center scientists say. This compares favorably with phosphoric acid cells, which require about 337 watts. The unit has operated efficiently with no apparent degradation of the electrolyte or gel matrix during 1,000 hours of electrolysis. No gaseous sulfur compounds arising from electrolyte degradation were revealed during mass spectrometric analysis.

Dynamic Liquid-Metal Plants Practical

by John F. Judge

CINCINNATI—With six years of work and thousands of hours in liquid metal testing behind them, General Electric researchers claim that large, high-temperature liquid-metal Rankine-cycle space power systems have reached the initial design stage.

Morris A. Zipkin, manager, space power and propulsion section (SPPS), Missile and Space Div., says the compatibility question is now settled. The recent culmination of a 5,000-hr. liquid-metal corrosion test proves conclusively that with the right preparation and adequate knowledge of the working fluids, it is easily possible to work with liquid metals at high temperatures.

"If there was a clear-cut mission requirement, we could charge in with the Rankine cycle with a high degree of confidence in ultimate success," says Zipkin.

The SPPS group leader bases his optimistic view on several factors:

—Completion of a 2,000-hour run with a two-stage potassium turbine that exhibited performance data almost exactly as predicted.

—Completion of a 5,000-hour potassium corrosion loop with no changes in system performance over the entire test run.

—Thousands of operational and materials tests resulting in a firm foundation of basic heat transfer and fluid flow design information on liquid metals.

—Electromagnetic pump improvements that reduce the weights by a factor of 10, making the units competitive with other canned pumps.

—A radiator cooling concept with a demonstrated ability to cut 50% from the weight of conventional radiator designs while providing for micrometeoroid puncture damage.

—A demonstrated ability in the design, joining and operation of systems using refractory metals and high-strength alloys coupled to new understandings of the materials functions in the systems.

All this has been accomplished for a combined outlay of less than $15 million since the facility was established in 1960. This includes both GE and NASA funding.

The work has also created a new art in instrumentation and test procedures. Very little had been done on such high-temperature systems before the GE effort.

Zipkin's group brought years of experience with steam and gas turbines, jet engines and boiling-water reactor technology to bear on the liquid-metal Rankine cycle. The limited budgeting posed additional problems—75% of the turbine test program was run with only one set of hardware.

Heat transfer—More than three years of fundamental heat-transfer work with liquid potassium is now completed. SPPS researchers are nearing the end of the combined data analysis operations. Major funding on all segments of the GE work has been through NASA's Lewis Research Center.

Results from the program form a substantial base for the thermal design of boilers and condensers for Rankine cycle space power systems using potassium as the working fluid at top temperatures of 2,100°F.

GE experts expect future efforts to lean more toward actual component development, such as multiple-tube boilers and condenser segment tests, as well as combined boiling and condensing tests under operational conditions.

There are three separate experimental loop facililties.

300KW-Two fluid facility—Designed to provide overall boiler tube performance data in the "once-through" mode, the facility has some 4,500 hours of operating time.

Specific data covers overall heat-transfer information, two-phase pressure drop and local heat transfer information in a single-tube test section at fluid conditions approximating those for space power boilers.

100KW high-temperature boiling facility—Designed specifically for local boiler performance data, this unit has accumulated 6,200 operating hours.

This facility studies heat transfer to boiling potassium at fluid temperatures up to 2,100°F in high vacuum. Future plans for the unit include conversion to a three-loop system (lithium-potassium-NaK) with substantially larger thermal power for advanced boiler and condenser tests in combination at actual space power system conditions.

50KW condensing facility—With more than 1,600 hours of operational time, this unit provides local condensing potassium heat-transfer coefficients and pressure-change data over the range of saturation temperatures from 1,100° to 1,450°F, local heat fluxes to 300,000 Btu/hr.-ft.^{2}, for two tube sizes without inserts and three insert combinations.

The next effort in condensers will probe multiple-tube geometries for stability problems. Then multiple condensers will be researched, especially their potential for oscillating with respect to each other.

Boiler progress—The heat-transfer data resulting from the thousands of hours in operational tests at SPPS is unique. In one case, specifically superheated vapor data points, the GE group has some 20 coefficient points—the only ones ever nailed down for these fluids.

This type of information differs from conventional theory since the potassium does not behave as an ideal liquid. The exact determination of such things as the critical heat flux point on a boiler tube will allow the design of an optimum boiler for any given set of system conditions.

The heat-transfer information leads to an understanding of how the liquids behave when coupled to other experimental information derived from the tests. This, in turn, provides an understanding of the fluid dynamics and thermodynamics in the systems—which is actually the foundation of intelligent design of operational systems.

Hidden behind the recent flood of basic data acquisition at GE is months of effort in learning how to work and live with refractory metals at high temperatures. Once this was in hand, the GE researchers had to develop measuring techniques and then wring them out so thoroughly that the data provided could be taken as real, and not clouded by instrument or method uncertainties.

Turbine development—A two-stage turbine finished 2,000 hours of endurance testing last December in the two-phase potassium facility.

The turbine program is designed to test and evaluate the performance and endurance of two stages of a prototype five-stage, 0.5-megawatt unit.

The endurance test was conducted at

a temperature of 1,500°F, a speed of 18,250 rpm and an inlet total-to-exit static pressure ratio of 3.47. There was no impact erosion found and what little corrosion was detected is thought to have been caused by the stainless steel components in the test loop.

GE experts are convinced the corrosion occurring in the 2,000-hour test would not take place in an all-refractory turbine system. The exact analysis is not yet completed.

The test stages involved were the third and fourth elements of a five-stage turbine. This is the toughest area in the turbine because the blades face the greatest danger of erosion caused by the moisture content of the potassium working vapor at these stages.

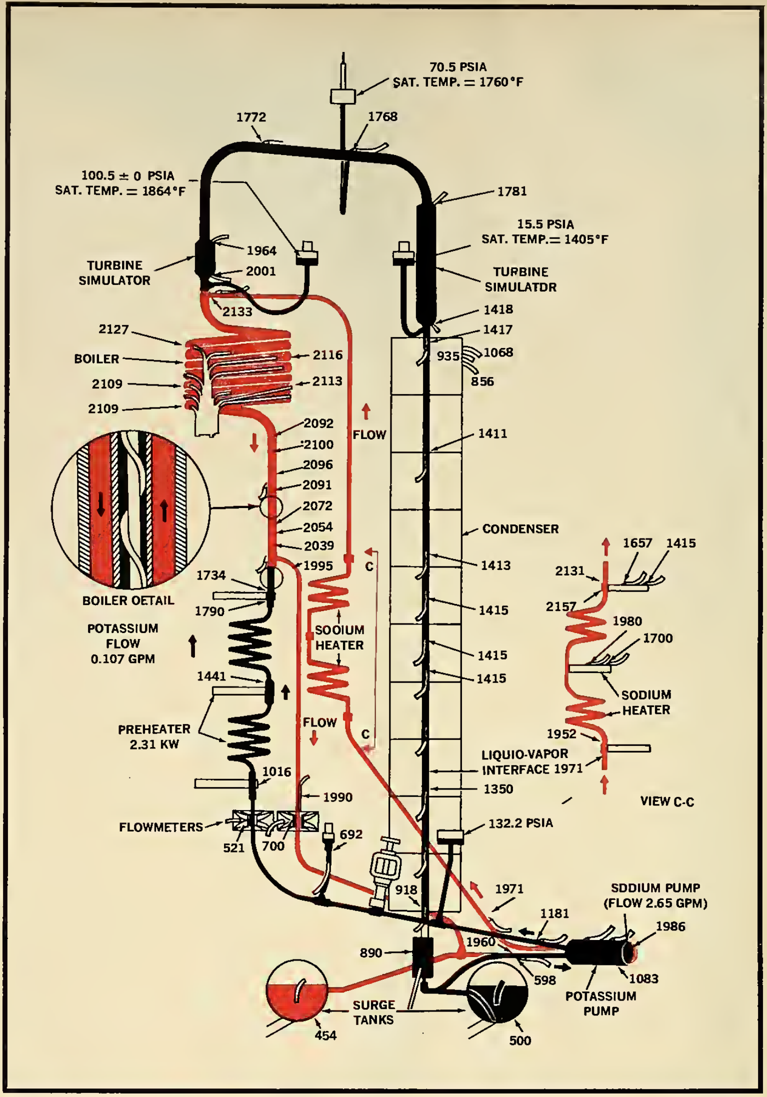
Ambitions—The next turbine run will reach for 3,000 hours and then a three-stage test setup will be investigated. Zipkin says there will be really wet vapor in this run in order to create the worst turbine operating conditions imaginable.

The test turbine's high-temperature rotor parts are fabricated from U-700, the shaft from A-286 and the static parts are fashioned from Haynes 25 alloy and stainless steels. Several U-700 blades in the second stage were replaced with molybdenum alloy units—specifically TZM (Mo 0.5Ti-0.08Zr) and TZC (Mo 1.25Ti-0.2Zr.-0.1C).

Performance factors such as efficiency, flow rates and power output deviation agreed closely with those predicted. This essentially means that GE experts now have a strong design grasp on a liquid metal turbine system.

The next turbine run will have small metal tabs inserted behind the stages and located to receive the full impact of liquid flung off the blade tips. This is actually designing erosion into the system and will provide information on the

(Continued on page 33)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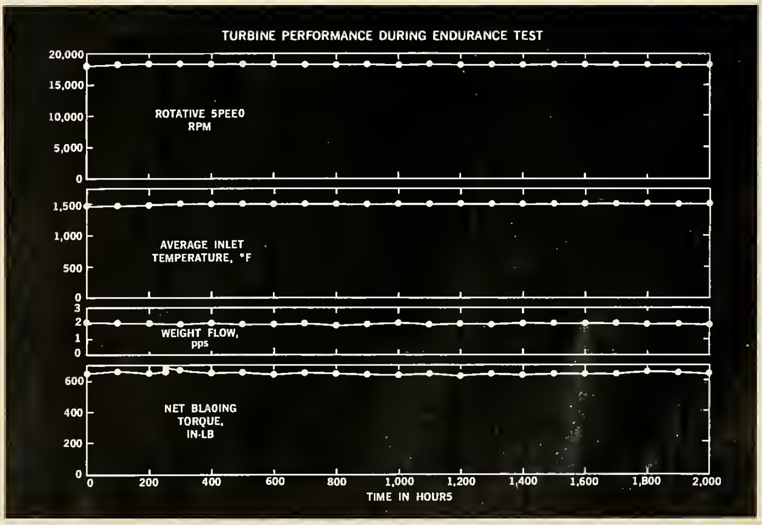

ABOVE: GE's prototype corrosion loop passed the 5,000-hour mark with potassium and sodium liquid-metal working fluids. Temperatures shown are in degrees F and the chamber pressure was 2.0 x 10^{-8} *torr. The loop uses columbium-1-zirconium tubing with TZN blades in the nine-stage nozzle-and-blade turbine simulator. Precise metallurgical analysis is still in progress, but GE researchers found little evidence of corrosion at shutdown last March. There was no perceptible change in performance during the entire run. RIGHT: Turbine performance during the 2,000-hr. endurance test. The close match between predicted and actual results for all performance data points provides GE researchers with a high degree of confidence in designing such dynamic systems for space applications.*

10

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ASTROLOG

Current Status of U.S. Missile and Space Programs

satellites and spacecraft

ADVANCED ORBITING SOLAR OBSERVATORY (NASA)

Republic, prime. DESCRIPTION: 1,250-lb. spacecraft to make detailed measurements of Sun's radiation; greater pointing accuracy (5 arc sec) than OSO; launch vehicle, THRUST AUGMENTED THOR-AGENA. STATUS: Project cancelled; telescope experiment may be added to APOLLO Applications.

APPLICATIONS TECHNOLOGY SATELLITE (NASA)

Hughes, spacecraft integration; GE, gradient stabilization. DESCRIPTION: Five-satellite program to test communication and meteorological equipment in spin-stabilized and gravity-gradient spacecraft in medium and synchronous orbits; test bed for gravity gradient stabilization, ion engine attitude control, photographic, and mass data collection experiments; weight, first spacecraft, 1,550 lbs., second, 782 lbs., others undetermined; launch vehicle, ATLAS-AGENA D. STATUS: Development; first flight scheduled for late 1966.

APOLLO (NASA)

North American, Command & Service modules, systems integration; Grumman, Lunar Excursion Module (LEM); MIT, guidance development; AC Electronics, guidance prime; Collins Radio, telecommunications; Honeywell, stabilization & control; AiResearch, environmental control; Northrop-Ventura, parachute recovery; Lockheed Propulsion Co., escape tower rocket; Marquardt, reaction controls; IBM, realtime computer complex; Westinghouse, power conversion equipment. Lunar Excursion Module, prime, Grumman; descent engine, TRW Systems Group; ascent engine Bell Aerosystems; environmental control, Hamilton Standard; reaction control thruster, Marquardt; guidance, MIT; radar & communications instruments, RCA; TMC, telemetry, Radiation Inc.; fuel cell, Pratt & Whitney; external visual display, Farand Optical; GE, acceptance checkout reliability; rendezvous optical system, Hughes. DESCRIPTION: Three-man spacecraft for Earth-orbital, lunar-orbital and lunar-landing missions. Boosters: SATURN I and SATURN IB for Earth orbits; SATURN V for lunar rendezvous and landing missions; 3-modular spacecraft: Command Module Weight, 5-1/2 tons; Service Module, 25 tons; Lunar Excursion Module, 15 tons; total weight, 95,000 lbs. STATUS: First of a series of unmanned orbital tests began with a boilerplate model launch of SA-7, Sept. 18, 1964; first flight-rated spacecraft launched successfully Feb. 23, 1966; lunar landing will be made in the 1968-69 period; first manned orbital flight due last half of 1966.

APOLLO APPLICATIONS (NASA)

No contractors named. DESCRIPTION: APOLLO spacecraft would be modified to provide extended life support and battery capability; two tanks would be removed from the Service Module propulsion section to provide room for additional consumable supplies; ascent stage of Lunar Excursion Module for extended operations in lunar orbit and on the lunar surface; many experimental payloads have been proposed, including orbiting telescopes, survey, mapping communications and many others. Boosters: SATURN IB and SATURN V. STATUS: Two or more firms to be selected for systems definition in May, 1966; about 20 flights are planned beginning in late 1968.

ATHENA (Air Force)

Atlantic Research, prime; Honeywell, guidance. DESCRIPTION: 17,500-lb. four-stage re-entry vehicle, attains apogees from 600,000 to 1,000,000 ft.; last two stages drive vehicle and payload earthward at near-ICBM velocities; major diameter, 32 in.; velocity package diameter, 28 in.; length, 51 ft. First-stage engine, Castor XM33 (Thiokol); second stage, either X261 (Thiokol) or X259 (Naval Propellant Plant); third stage, 30KS8000 (Aerojet); fourth stage, Ranger Retro BE3, Hercules. STATUS: Engaged in sub-scale testing of advanced re-entry concepts in ABRES program; AF will buy 36 more vehicles for some $14 million which will carry program far beyond initial 77-flight plan; advanced version proposed to AF for 450-lb. payload.

BIOSATELLITE (NASA)

GE, prime. DESCRIPTION: 1,000-lb. satellites to test effects of space environment on plants, animals (primates) and other biological specimens; launch vehicle, THRUST-AUGMENTED DELTA. STATUS: Six flight models to be built; first flight in late 1966; others to follow at three-month intervals; 14 experiments selected for first flight.

COMSAT CORP. SATELLITE PROGRAM

TRW picked for contract negotiations for advanced worldwide satellite system; spacecraft would have capacity of some 1,200 two-way voice circuits and be launched into synchronous orbits; delivery of first six satellites 24 months after signing; launch vehicle not yet selected; Sylvania Electric Products to provide antenna systems at Washington State, Hawaii Earth stations, with delivery to start May 1, 1966; corporation also working on system for use with APOLLO program and commercial communications; Hughes aircraft awarded contract for four synchronous satellites, with two to be orbited probably in August; Page Communications Engineers to provide transportable Earth stations; Comsat also studying bids from 7 firms for multipurpose synchronous satellite; EARLY BIRD, 85-lb. experimental/operational satellite built by Hughes, launched April 6 and now in synchronous orbit over Atlantic, transmitting between U. S. and Europe.

DISCOVERER (Air Force Program 622A)

Lockheed, prime; GE, re-entry vehicle. DESCRIPTION: THOR-AGENA and ATLAS-AGENA launchings of stabilized satellites; main purpose is to test techniques and components for military space systems. STATUS: All data on program classified as part of DOD information policy; however, indications are that program has been cut back or ended as more economical vehicles have come into use.

ECHO (NASA)

Langley Research Center, prime. DESCRIPTION: ECHO I, 100-ft. inflatable sphere in 700- to 805-mi. orbit; passive communication satellite; booster, THOR for ballistic tests; THOR-AGENA for orbital. STATUS: Program complete; ECHO I in orbit since Aug. 12, 1960; two ballistic shots in 1962 unsuccessful; ECHO II (135-ft.) launched from Vandenberg Jan. 27, 1964; U.S.-USSR conducting experiments using ECHO.

ESSA (Environmental Science Services Administration)

RCA, prime; DESCRIPTION: 285-lb. operational weather satellite launched into polar orbit by the THRUST-AUGMENTED DELTA; ESSA based on the TIROS wheel configuration; future satellites will have the Advanced Vidicon Camera System (AVCS) in addition to the Automatic Picture Transmission (APT) system. STATUS: ESSA I launched on Feb. 3, 1966, and ESSA II launched on Feb. 28, 1966, into polar orbit to form the first operational weather satellite system; plans call for keeping two satellites—one with AVCS and one with APT—in orbit at all times for global weather coverage.

GEMINI (NASA)

McDonnell, prime; Rocketdyne, spacecraft propulsion; General Electric, fuel cell; IBM, guidance system integration and computer; Honeywell, guidance; Westinghouse, rendezvous radar; AiResearch, environment. DESCRIPTION: Bigger and heavier MERCURY-type capsule to carry two men for up to two weeks; TITAN II used as booster; ATLAS-launched AGENA will be used for rendezvous missions; 15 spacecraft will be produced. STATUS: Development; 12 flights planned; will be used to determine feasibility of rendezvous for lunar mission and long-duration manned flight; first unmanned flight, April, 1964, successful; second unmanned orbital flight, January, 1965, successful; first manned flight successful March 23; second flight successful, June 3-7, 1965, including first extravehicular activity; eight-day GEMINI 5 flight, Aug. 21-29; successful; GT-7 flight, launched Dec. 4, set world record for manned spaceflight duration (14 days); GT-6 launched Dec. 15 after two previous attempts scrubbed; first space rendezvous achieved Dec. 15 during 14-day GEMINI 7 flight when GEMINI 6 on one-day mission came within one foot of sister craft; GEMINI 8 flight, March 16, achieved first space docking but mission aborted after 16 hours, 42 minutes, after maneuvering propulsion unit malfunction; GEMINI 9 scheduled for May 13; three more flights planned in 1966; AF participating in program, and will modify GEMINI capsule for MOL.

GEOS (NASA)

Applied Physics Laboratory, prime. DESCRIPTION: 350-lb. geodetic satellite (similar to ANNA) to carry flashing-light beacons, electronic beacons and optical and radar reflectors; launch vehicle, IMPROVED DELTA; 700-900-mi. orbit at a 59-degree inclination. STATUS: First flight launched successfully Nov. 6, 1965; PAGEOS passive satellite developed by Langley Research Center will also be launched June 21, 1966.

HYPERSONIC RESEARCH VEHICLE (Air Force, NASA)

No contractors announced. DESCRIPTION: Manned hypersonic spacecraft capable of Earth-to-orbit-and-return; turbofan, Mach 0-3; ramjet, Mach 3-8 or 10 (oxygen collected and liquefied during this cycle); Mach 8-10 orbital speeds, LH_2-LOX rocket. STATUS: Joint NASA-AF research program approved; NASA funding $5 million in FY '66; AF has advanced technology program in six pertinent areas (mostly engine developments) in FY '65. GE, Pratt & Whitney and Marquardt selected for conceptual and preliminary design of a research engine; engine flight test planned for 1968.

ICBM ALARM (Formerly MIDAS) (Air Force Program 239A)

Lockheed, prime; Aerojet, IR detector system. DESCRIPTION: Early-warning random-orbit satellite; detect ICBM launchings by IR; two flights conducted in 1963 detected solid and liquid missile launches; satellites are launched piggy-back on various AF boosters. STATUS: Program remains in R&D but major improvements to sensors; ICBM warning will be included in new Air Force multi-purpose satellite, with nuclear detection and meteorological sensors; RFP for new satellite expected in May.

INTERPLANETARY MONITORING PLATFORM (NASA)

Goddard Space Flight Center, prime; Martin Co. developing nuclear power unit; BTL/Univac, guidance. DESCRIPTION: 131 to 181-lb. satellite launched into cislunar-space orbit with an apogee of more than 100,000 mi.; will measure radiation and solar flare hazards in advance of Project APOLLO; launched by DELTA and THRUST-AUGMENTED DELTA boosters from AMR. STATUS: IMP-I launched in December, 1963; IMP-II launched Oct. 4, 1964; IMP-III launched May 29, 1965; four more satellites are planned, two to be placed in lunar orbit; later flights will use a nuclear power unit as replacement for solar cells; designation, IMP-I is EXPLORER XVIII; IMP-II is EXPLORER XXI.

ISIS (Canada, U.S.)

Canadian Defense Research Board, satellite; NASA, launch vehicle. DESCRIPTION: Three-satellite follow-on program to ALOUETTE to continue ionospheric studies. STATUS: Design of ISIS A began in 1964 with launch planned in 1967; B and C to be launched in 1968, 1969; launch vehicle, THOR-AGENA.

LES (Air Force)

M. I. T. Lincoln Laboratory, prime; consulting support, TRW Systems Group. DESCRIPTION: a series of Lincoln Experimental Satellites carried as TITAN III-A and III-C "bonus" payloads to test military comsat devices and techniques. STATUS: First launch Feb. 11 failed; second, May 6, achieved orbit; LES-3 and 4 launched Dec. 21 are operating but in wrong orbit because of TITAN control failure.

LUNAR LOGISTICS SYSTEM (NASA)

Studies have been conducted by Grumman, TRW Systems Group and Northrop. DESCRIPTION: Spacecraft to carry support payloads to the Moon. Two designs under study—LEM truck with 7,000-lb. payload and logistics spacecraft with 25,000 to 30,000-lb. payload; booster, SATURN V. STATUS: Program definition of the LEM truck planned in FY '67; program would cost about $1 billion; first step will be to extend lunar stay-time up to two weeks.

LUNAR ORBITER (NASA)

Boeing, prime; RCA, power and communications; Eastman Kodak, cameras; Marquardt, maneuvering engine. DESCRIPTION: 800-lb. spacecraft launched by ATLAS-AGENA will orbit Moon, taking pictures of lunar surface; radioactive and geodetic measurements will also be taken. STATUS: Five flights scheduled beginning in third quarter, 1966.

MANNED ORBITING LABORATORY (Air Force)

Douglas Aircraft Co., prime; GE, on-board experiments; Aerospace Corp., technical management. DESCRIPTION: Two-man spacecraft to establish military usefulness of man in space; booster, TITAN III-C; GEMINI-X capsule atop 10-ft.-dia., 41-ft.-long canister lab; total weight about 25,000 lbs., orbit below 350 mi.; flights of 30 days in shirt-sleeve environment planned. STATUS: Six-launch program now planned; 30-day missions; 60-90 day missions under study; $159 million in FY '67 funding; unmanned Gemini canister launch, late 1966 or 1967; manned GEMINI canister launch, 1969; rendezvous and ferry capability possible; Honeywell and Collins Radio winners of attitude control and communications subsystems; Hamilton-Standard for life support; Pratt & Whitney for fuel cell; either IBM or Sperry Rand for data management; full-scale hardware development this summer following completion of revised system definition studies.

MARINER (NASA)

Jet Propulsion Laboratory, prime. DESCRIPTION: 570-lb. unmanned spacecraft for early interplanetary missions to vicinity of Mars and Venus; boosted by ATLAS-AGENA. STATUS: First scheduled Venus fly-by, August, 1962, unsuccessful after booster failure; second passed within 21,594 mi. of Venus, Dec. 14; two Mars fly-by spacecraft launched in November, 1964; first on Nov. 5 failed due to shroud malfunction; MARINER IV launched Nov. 28, flew by Mars July 14, 1965, and transmitted the first closeup photos of the planet; MARINER flight to Venus in mid-1967, and two flights to Mars in 1969 are planned.

MILITARY COMMUNICATIONS SATELLITE

Aerospace Corp., systems engineering & technical direction; Philco, prime. DESCRIPTION: Multiple-launch, random, active repeater comsat; 24 satellites launched in groups of 8 satellites in 18,300-n.mi. polar orbits; weight about 100 lbs.; TITAN III-C booster. STATUS: Full-scale development as an R&D and "interim" operational system; first launch mid-June; DCA has contracted industry studies on a longer-lived Advanced Communication Satellite system; operational status planned in 1969; tactical system also planned.

NATIONAL ORBITING SPACE STATION (NASA, Air Force)

Many studies awarded. DESCRIPTION: Manned space station with orbital lifetime of one to five years for testing components and techniques in the space environment; weight ranges under study vary from 15,000-20,000 up to 200,000 lbs. STATUS: Decision not expected for two to four years. MANNED ORBITING RESEARCH LABORATORY and LARGE ORBITING RESEARCH LABORATORY being considered.

NIMBUS (NASA)

Goddard Space Flight Center, prime; GE, integration and testing; RCA, vidicon cameras. DESCRIPTION: 900-1,100-lb. second-generation weather satellite; Earth-stabilized polar orbiting; TV cameras and IR scanners in payload; THRUST-AUGMENTED THOR-AGENA B booster. STATUS: First launching successful Aug. 28, 1964; picture & IR quality good in spite of satellite's elliptical orbit; satellite quit transmitting Sept. 23, 1965; second scheduled for May, 1966, third in 1967 and fourth in 1968-69.

NUCLEAR DETECTION SATELLITES (Formerly Vela) (ARPA)

TRW Systems Group, prime; Los Alamos Scientific Lab/Aerospace Corp., payload. DESCRIPTION: 20-sided, 560-lb. satellite for detection of nuclea explosions in space; 50,000-mi. orbit; booster, ATLAS-AGENA; launched in pairs. STATUS: First pair successfully launched in October, 1963; second and third pairs successfully launched July, 1964, and July, 1965; two pairs remain; next aboard TITAN III-C next fall; $8 million in new funding; future systems may go aboard multi-purpose satellites.

ORBITAL VEHICLE (Air Force)

Series of vehicles under OAR project to orbit small scientific experiments at low cost; first two satellites, OV1-1 and -3, both failed, first due to separation mechanism in flight and second due to launch vehicle explosion; first flight was first known attempt to launch satellite from an ATLAS-ABRES vehicle on ballistic trajectory; OV2-1, developed by Northrop, also fell victim to faulty Titan III-C Transtage Oct. 15; OV2-3 also failed due to Dec. 21 TITAN III-C Control malfunction; space General at work on OV3; OV-1 was successfully launched Oct. 5 aboard an ATLAS-D; program may shift away from using TITAN.

ORBITING ASTRONOMICAL OBSERVATORY (NASA)

Grumman, prime; Westinghouse, ground station, components; GE, stabilization and control; Kollsman, star trackers; IBM, data processor and storage; Hughes and Avco, communications equipment. DESCRIPTION: 3,600-lb. orbiting astronomical satellite to study ultraviolet spectrum from approximately 1,200 Å to 4,000 Å; four major experiments selected; one piggyback; booster, ATLAS-AGENA D. STATUS: First flight unsuccessful on April 8, 1966.

ORBITING GEOPHYSICAL OBSERVATORY (NASA)

TRW Systems Group, prime; DESCRIPTION: 1,000-lb. satellite with instruments for geophysical measurements; polar (POGO) and eccentric (EGO) shots planned; can carry more than 20 experiments; ATLAS-AGENA, THRUST-AUGMENTED THOR, booster. STATUS: First launch Sept. 4, 1964, partially successful; 16 of 20 experiments working; OGO II launched Oct. 14, 1965 ceased operation Oct. 24, when electrical power failed; third scheduled May 20, 1966; three more planned.

ORBITING SOLAR OBSERVATORY (NASA)

Ball Brothers, prime. DESCRIPTION: OSO I, 458-lb. orbiting solar observatory; OSO II, 535-lbs.; booster, DELTA; S-16 early version; S-17 and S-57 advanced versions. STATUS: First flight March 7, 1962, highly successful second flight, Feb. 27, 1965, successful. Third satellite, launched Aug. 25, 1965, failed to achieve orbit because of premature fourth stage ignition, six more flights planned, with next flight in June, 1966.

PEGASUS (NASA)

Fairchild Hiller, prime. DESCRIPTION: 3,400-lb. meteoroid-detection satellite employing two 50 x 15 ft. extendable detector wings; Earth orbit 300 to 800 mi.; booster, SATURN I. STATUS: Development; will measure size, energy and frequency of meteoroids to evaluate hazards of impact with manned spacecraft; first launch successful in

February; PEGASUS B, May 25, 1965, and PEGASUS C, July 30, 1965, also successful. No more launches planned; formerly known as METEORIOD DETECTION SATELLITE.

PIONEER (NASA)
TRW Systems Group, prime. DESCRIPTION: 130-lb. spin-stabilized solar probe; AUGMENTED DELTA launch vehicle; cylindrical; covered with 10,000 solar cells; four outrigger booms for stabilization; five experiments, 60 to 90-million-mi. communication capability. STATUS: Seven launches in program; first spacecraft launched successfully Dec. 16, 1965; EXTENDED PIONEER under study.

PROJECT SCANNER (NASA)
Honeywell, fabrication and integration; Baird-Atomic, star-mapper telescope; Santa Barbara Research Center, dual radiometers. DESCRIPTION: Unmanned scientific satellite to measure natural radiation gradients of Earth's horizon to determine utility of spacecraft horizon sensors. STATUS: Flights to begin in 1966.

RADIO ASTRONOMY EXPLORER (NASA)
Goddard, prime for first two spacecraft with industry to build remaining four. DESCRIPTION: 270-lb. satellite which will have four 750-ft. extendable antennas to pinpoint radio emissions in space. STATUS: Hardware funding approved in FY '65 & '66 budgets, with first launch by a THRUST-AUGMENTED DELTA in 1967.

SAMOS (Air Force Program 720A)
Lockheed, prime; photo intelligence equipment, Eastman Kodak; capsules, GE; parachute and guidance recovery equipment, Avco and Northrop Ventura. DESCRIPTION: Reconnaissance satellite; formerly SENTRY; R&D model weighs 4,100 lbs. with E-5 capsule (3,000 lbs. with E-6); booster, ATLAS-AGENA; 100-300-mi. circular polar orbit. STATUS: Operational; advanced SAMOS under development; a successor system, capable of changing orbital plane and altitude on command, is apparently being developed; this newer reconnaissance satellite would have up to six recoverable data capsules or cassettes with lifting-body characteristics, permitting data recovery without returning entire satellite to Earth; could be launched by the TITAN III-B booster now under development; FERRET version used for electronic intelligence and communications eavesdropping.

SATAR (Air Force)
General Dynamics, prime. DESCRIPTION: 300-lb. scientific satellite pod-mounted on side of ATLAS booster; length, 55 in.; diameter 27 in.; 200-lb. payload; orbits vary from 500 to 2,000 n. mi.; as re-entry vehicle, gains speeds up to 30,000 fps; guidance, strap-down system with three orthogonally mounted gyros; unstabilized when in orbit. STATUS: Development; seven vehicles being built under present contract; pods of SATAR type have been flown on 44 missions.

SATELLITE INSPECTOR (Air Force PROGRAM 706)
No contractors announced. DESCRIPTION: Satellite inspection system consisting of a spacecraft capable of co-orbital inspection of non-cooperative satellites. STATUS: Conceptual studies continue.

SECOR (Army)
Cubic Corp., prime, transponder and ground stations; ITT Labs, satellite vehicle. DESCRIPTION: 40-lb. geodetic satellite; rectilinear, measuring 9 x 11 x 14 in.; can be carried piggyback on a variety of boosters; frequency, 162-324 mc for geodetic measurements; 54-216 mc for refraction studies. STATUS: Operational SECOR vehicles 1, 3, 2, 4 and 5 now in orbit, launched in order of mention. SECOR 5, launched Aug. 10, 1965, is the only non-rectilinear satellite in the series, being a 20-in. polished sphere; future SECORS will be rectilinear; expanded program at altitudes of 1,800 mi. is being considered.

SERT (NASA)
RCA, prime. DESCRIPTION: Spinning ballistic test vehicle carrying two electric-propulsion engines for environmental tests. STATUS: First flight July 20, 1964, from Wallops Island, Va., carried a Lewis electron bombardment engine and a Hughes contact ionization engine; the Lewis engine worked well while Hughes engine produced no thrust; follow-on flights cancelled since SERT I proved neutralization of an ion-beam in space; SERT III now under study.

START (Air Force)
Sequential Air Force program to develop advanced spacecraft re-entry techniques; Martin Co. named winner of PILOT phase with new SV-5P manned vehicles; firm was also PRIME phase contractor with SV-5D; Aerospace Corp., general systems engineering and technical direction. DESCRIPTION: A four-part experimental program, beginning with ASSET, to explore the materials, structures, flight regimes and other areas related to glide atmospheric entry. STATUS: Follow-on phases include PRIME, PILOT, and a high L/D ratio vehicle; PRIME portion to get $16 million in FY '67 for four sub-orbital flights aboard ATLAS to test maneuverable re-entry of data capsules.

SURVEILLANCE CALIBRATION (Navy)
NRL designed and developed satellites for calibrating ground-based systems; 12 satellites launched to date; Latest Aug. 13; five satellites launched aboard single THOR ABLESTAR to check performance of Navy space surveillance system.

SURVEYOR (NASA)
Hughes, prime; Martin, SNAP device. DESCRIPTION: 2,150-lb. spacecraft for soft-landing 100-300 lbs. of instruments on Moon; nine 2,500-lb. spacecraft are also planned; booster, ATLAS-CENTAUR; SNAP nuclear generator optional. STATUS: First Moon flights May, 1966; seven engineering and three operational spacecraft planned.

SYNCOM (NASA)
Hughes, prime. DESCRIPTION: 24-hr.-orbit instantaneous narrow-band, active-repeater communications satellite; 28 in. in dia. and weighs about 63 lbs.; booster, DELTA; capable of accommodating one full duplex radio telephone channel. STATUS: First launch failed, Feb. 14, 1963; satellite believed to be in orbit but contact lost; SYNCOM II launched July 26, 1963, completely successful; third launch Aug. 19, 1964, successful; satellite positioned in stationary orbit over Pacific; DOD has taken over satellites for military traffic.

SMS (Synchronous Meteorological Satellite) (NASA)
Republic, RCA Astro-Electronics, Hughes, study contracts. DESCRIPTION: 24-hr. weather satellite, Earth-stabilized; TV cameras with variable focus; may use SNAP-50 for power; booster may be ATLAS-AGENA or -CENTAUR. STATUS: Studies to continue; development funds not included in FY '66 budget; ATS and TIROS expected to provide major inputs to the program.

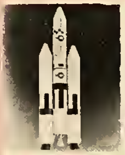
TIROS (NASA, Weather Bureau)
RCA, prime. DESCRIPTION: 285-lb. meteorological satellite; TV pictures of cloud cover; IR sensors to gather heat balance data; one TIROS to be tested for effectiveness in highly elliptical orbit (300-3,000 mi.). STATUS: R&D; 10 satellites launched; all successful.

TRANSIT (NAVY)
Applied Physics Laboratory, prime; Martin, SNAP device; Westinghouse, shipboard satellite signal receivers. DESCRIPTION: Navigational satellite; R&D model over 250 lbs.; operational, 50 to 100 lbs.; operational system; four satellites in random, near-circular 600-mi. orbits; SNAP nuclear generator; ABLESTAR, SCOUT boosters. STATUS: Four-satellite system operational since July, 1964; system established for use by POLARIS subs and surface ships; two nuclear-powered (SNAP-9A) satellites launched in 1963; NASA studying commercial system; simplified satellite and ground equipment under study.

TRS (Air Force)
TRW Systems Group, prime. DESCRIPTION: 3-lb. scientific satellite to measure radiation; four-sided, measuring 9 in. on a side. STATUS: Operational; first launched piggyback on DOD payload Oct. 17, 1963.

VOYAGER (NASA)
Either Boeing, GE, or TRW Systems Group will be selected for spacecraft program definition in about a year. DESCRIPTION: Unmanned 7,000-11,000-lb. MARINER follow-on spacecraft bus/lander to orbit Mars and eject a capsule to the surface. STATUS: Development expected to begin in early 1967; lander design to be studied in 1967; program definition funded in FY '66; first launch delayed until 1973; spacecraft to be launched by SATURN V, and will be used to explore other planets through 1970's.

X-15 (NASA, Air Force, Navy)
North American, prime; Thiokol, propulsion; Sperry Gyroscope, inertial flight data system; Honeywell, adaptive flight control electronics. DESCRIPTION: Manned rocket plane capable of 4,000-mph-plus flight at edge of space; single rocket engine develops 57,000 lbs. thrust. STATUS: Powered flights in progress; unofficial records set—altitude 354,200 ft. and speed 4,104 mph; hypersonic propulsion research program should run through 1968; more than 100 flights have been made; ramjet (X-15A2) flights scheduled for 1968.



space vehicles

ABLESTAR (Air Force)
Space-General, prime; Aerojet, propulsion; Space-General/Bell Telephone, guidance. DESCRIPTION: 2,000-lb. upper stage; 9.5 ft. long; 55 in. dia.; radio command guidance; propellants, UDMH/IRFNA; restart capability. STATUS: Used in TRANSIT and other military programs; THOR booster.

ATLAS-AGENA D (Air Force)
General Dynamics/Convair (ATLAS); Lockheed (AGENA); TRW Systems Group, AGENA B; Honeywell, inertial reference. DESCRIPTION: 275,000-lb. booster; payload capability, 5,000 lbs., in 345-mi. orbit, 750 lbs. to escape; length, 102 ft.; base diameter, 10 ft.; liquid propulsion; modified ATLAS D with 360,000-lb. thrust; AGENA B with 15,000-lb. thrust; restart capability. STATUS: Operational; used in RANGER, DISCOVERER, MILITARY COMSAT, MARINER, LUNAR ORBITER, OAO, SAMOS and other programs. ATLAS Standard Launch

Vehicle developed for AF space programs; ATLAS launches from WTR being used in conjunction with ATHENA launches at Green River, Utah, in an effort to develop scaling laws for re-entry bodies (Advanced Ballistic Re-entry Systems program).

AGENA D (Air Force)
Lockheed, prime; Honeywell, guidance; Bell, propulsion. DESCRIPTION: 1,700-lb. upper stage; 25 ft. long; 5 ft. dia.; all-inertial guidance; propellants, UDMH/IRFNA; multiple re-start capability; ATLAS, THOR and AUGMENTED THOR boosters. STATUS: Used in DISCOVERER, SAMOS and other military programs as well as a variety of NASA programs; e.g., MARINER, RANGER, OAO and OGO.

CENTAUR (NASA)
Lewis, program management; General Dynamics/Convair, prime; Pratt & Whitney, propulsion; Honeywell, guidance. DESCRIPTION: High-energy upper stage using a pair of RL-10 LOX/liquid hydrogen engines; 30,000 lbs. total thrust; 30 ft. long; 10 ft. dia.; ATLAS D booster; capable of orbiting 8,500 lbs.; 2,300 lbs. to escape; 1,300 lbs. on planetary flights. STATUS: Development; first flight failed; second launch Nov. 27, 1963, successful; third, June 20, 1964, partially successful; fourth flight Dec. 11, 1964, successful; fifth flight Mar. 2 failed when ATLAS-CENTAUR exploded on pad; CENTAUR 6, Aug. 11, 1965, successful; CENTAUR 8 flight unsuccessful on April 7, 1966, when engines failed to orbit; first SURVEYOR flight also scheduled for second quarter 1966.

DELTA (NASA)
Douglas, prime; Bell Telephone Labs, guidance; Rocketdyne/Aerojet/Allegany Ballistics Laboratory, propulsion. DESCRIPTION: Successor to THOR-ABLE; upper-stage guidance; three-stage vehicle; 800-lb. payload capability in 100-mi. orbit; THRUST-AUGMENTED DELTA payload capability, 1,500-plus lbs. in 100-mi. orbit; THOR missile comprises first stage. STATUS: Launch vehicle for TIROS, EXPLORER, OSO, BIOS, ECHO; TAD used for SYNCOM & PIONEER; 26 previously on order augmented by AF order for 21 more for NASA; THRUST-AUGMENTED DELTA with three solid motor strap-ons also being used.

LITTLE JOE II (NASA)
General Dynamics/Convair, prime. DESCRIPTION: Solid-propelled vehicle with 800,000-lb. thrust; launch vehicles for APOLLO suborbital flights. STATUS: Three launches; Aug. 28, 1963; May 13, 1964; Dec. 8, 1964, successful; May 19, 1965, launch unsuccessful; last flight Jan. 20, 1966 successful.

POST-SATURN V LAUNCH VEHICLE (NASA)
Under study. DESCRIPTION: No firm concept but will be significant improvement over SATURN V (20-30 million-lb.-thrust first-stage large solid motors, and nuclear upper stage under consideration). STATUS: Study to determine characteristics; operational target date post-1975.

ROVER (NASA, AEC)
Los Alamos Scientific Labs, ROVER prime; Aerojet, NERVA prime; Westinghouse, propulsion. DESCRIPTION: First nuclear rocket; tests of Kiwi, prototype of NERVA engine, under way. STATUS: Kiwi tests completed this year; NERVA tests highly successful; full systems tests of engine now set for fall, 1965—12 months ahead of schedule; development of Phoebus reactor initiated; no flight test program funded at present.

SATURN I (NASA)
Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler Corp.; S-IV, Douglas. DESCRIPTION: Two-stage vehicle for early boilerplate tests of APOLLO and PEGASUS; first stage: eight Rocketdyne H-1 engines; second stage: six Pratt & Whitney RL-10-A3 engines; 22,500 lbs. into 345-mi. orbit. STATUS: Four flight tests of first stage successful; all flights with inert upper stage; first flight with live upper stage successfully launched Jan. 27, putting 37,700 lbs. in low Earth orbit; SA-6 May 28, 1964 and SA-7 Sept. 18, 1964, also successful; SA-9 on Feb. 16 put PEGASUS satellite into orbit; SA-8, May 25, and SA-10, July 30, 1965, also successful, completing R&D program.

SATURN IB (NASA)
Systems engineering, assembly and guidance, Marshall Center; S-1 stage, Chrysler; S-IVB stage, Douglas. DESCRIPTION: S-1, eight H-1 engines; S-IVB, one J-2 engine; payload capability, 35,000 lbs. in 105-mi. orbit. STATUS: Development; first flight successful Feb. 23, 1966; boost APOLLO spacecraft boilerplate models, including lunar landing vehicle; first manned flight in APOLLO program set for October, 1966; advanced version able to orbit 30 tons under consideration.

SATURN V (NASA)
Systems engineering, assembly and guidance, Marshall Space Flight Center; S-IC stage, Boeing; S-II, North American; S-IVB, Douglas; F-1 engine, North American; J-2, North American. DESCRIPTION: S-IC, five F-1 engines; S-II, five J-2 engines; S-IVB, J-2 engine; 140-ton payload in 105-mi. orbit; 95,000 lbs. to escape velocity; 30 tons for planetary missions. STATUS: R&D; first flight scheduled for 1967; prime booster for APOLLO missions; will be used to boost orbiting space station.

SCOUT (NASA)
LTV Aerospace Corp., prime; Honeywell, guidance; Aerojet/Thiokol/Allegany Ballistic Laboratory, propulsion. DESCRIPTION: Solid propulsion four-stage satellite launcher; 72 ft. long; 3.3 ft. dia.; 240-lb. payload in 345-mi. orbit; 80 lbs. to escape. STATUS: Operational; used by NASA for EXPLORER and other small payloads; also procured by NASA for Air Force as BLUE SCOUT.

THOR-ABLESTAR (Air Force)
Douglas, prime; Bell Telephone Labs/Univac, guidance; Rocketdyne, first-stage propulsion; Space-General, second; DESCRIPTION: Two-stage vehicle with 181,900 lbs. total thrust; performance, 900 lbs. in 100-n.-mi. orbit; length, 55.9 ft., diameter, 8 ft., weight, 118,200 lbs., height, 79 ft.; guidance, radio command; STATUS: Operational; used in TRANSIT, GEOS and other military programs; second stage, under development by Boeing, called BURNER II, a solid-fueled package designed to bridge gap between SCOUT payloads and THOR AGENA and THOR ABLESTAR upper stages; BURNER II can be adapted to both TITAN and ATLAS boosters.

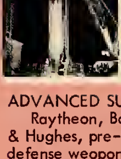
THOR-AGENA D (Air Force and NASA)
No prime; Douglas, THOR frame; Lockheed, AGENA D; Rocketdyne, propulsion. DESCRIPTION: Liquid-propulsion vehicle to put 1,600-lb. payload in 300-mi. orbit; length, 76 ft.; diameter, 8 ft.; launch weight, 123,000 lbs.; 172,000 lbs. thrust; THOR, radio guidance, AGENA, all-inertial. STATUS: Operational; used in AF space program, TELSTAR, Topside Sounder and other NASA programs; NASA has 11 launches scheduled.

THRUST-AUGMENTED DELTA (NASA)
Douglas, prime; Thiokol, solid propulsion. DESCRIPTION: DELTA launch vehicle with three strap-on solids; performance, 1,000 lbs. to Earth orbit; 150 lbs. to escape; propulsion, three XM-33 solid motors producing 55,000 lbs. thrust each. STATUS: Development; to be used for BIOSATELLITE, PIONEER, SYNCOM, TIROS, COMSAT programs; initial flight Aug. 19, 1964, successful.

THRUST-AUGMENTED THOR (Air Force/NASA)
No prime; Rocketdyne and Thiokol, propulsion. DESCRIPTION: THOR-AGENA with 3 strap-on solids; THOR liquid propulsion, 172,000 lbs. of thrust; each strap-on, 55,000 lbs. thrust; performance, 2,500 lbs. in 100-n.mi. orbit. STATUS: Operational; used for NIMBUS, POGO and other payloads too heavy for THOR, but not heavy enough for ATLAS. AF has ordered 22 new "long tank" versions of THOR from Douglas to upgrade the TAT payload with greater thrust and longer burn-time; main engine thrust, 348,000 lbs.; solid strap-ons upgraded to 70,450-lb. thrust each.

TITAN II (GLV) (NASA)
Aerospace Corp., systems engineering & technical direction; Martin, prime. DESCRIPTION: Manned space booster; Essentially TITAN II with addition of redundant electrical power and flight control systems, malfunction detection system and radio command guidance. STATUS: Development; GT-2 (unmanned version) launched Jan. 19; GT-3 successful on March 23; GT-4, June 3, and GT-5, Aug. 21, also successful, as were GT-7 Dec. 4 and GT-6 Dec. 15.

TITAN III (Air Force Program 624A)
Aerospace Corp., systems engineering & technical direction; Martin, systems integration; United Technology, large solid boosters; Martin, TITAN II portion; Aerojet-General, liquid engines (Transtage); Martin, standardized upper stage; AC Electronics, guidance. DESCRIPTION: Quick-reaction vehicle for military space missions; will be used to boost MOL/GEMINI-B; Zero stage, two 120-in. solid motors; first and second stages, TITAN II (storable propellants); third stage is liquid Transtage; modified TITAN II guidance; payload, 25,000 lbs. in 100-n.mi. orbit, 2,100 lbs. to 22,300-mi. orbit; 5,000 lbs. to escape; STATUS: Development; first flight Sept. 1, 1964 (T-IIIA) achieved primary and secondary objectives, but failed to achieve orbit; second flight (T-IIIA) successful Dec. 10, 1964; first full TITAN III-C flight successful June 18, 1965; second flight Oct. 15, successful launch followed by partial Transtage failure; third launch Dec. 21 also had partial control failure; eight remaining III-C R&D flights; next three for IDSCP; development stretchout moves operational date to June, 1967; a non-man-rated version—TITAN III-B—being studied as more cost-effective booster for satellite launches; uses first two TITAN III-A stages and an AGENA upper stage; first launch, mid-1966; 24 vehicles planned as initial buy; 3-8 more III-C's planned for FY '68; 7-segment version of III-C with 30,000-lb. capability to boost MOL into near-Earth orbit.



missiles

ADVANCED SURFACE MISSILE SYSTEM (Navy)
Raytheon, Boeing, Sperry Rand, General Electric, Westinghouse, RCA & Hughes, pre-program definition contracts. DESCRIPTION: Fleet air-defense weapon for the 1970 time period; to have capability against aircraft and certain types of air-to-surface missiles; will replace the 3-T systems currently in the fleet. STATUS: Will remain in early development status for one year while Army's SAM-D project is monitored for possible ASMS commonality; Navy requests $2 million for ASMS in FY '67.

.FA (RUR-4) (Navy)

Navy, prime; Avco, frame; Naval Propellant Plant, propulsion. DE-
RIPTION: ASW, surface-to-underwater; weight, 500 lbs.; solid pro-
lsion; H.E. depth charge; range, 1,000 yds.; guidance, free-flight.
ATUS: Operational; deployed on destroyers and cruisers; being re-
aced by ASROC.

NTI-SATELLITE WEAPON (Army/Air Force)

Boeing, AF program; Hughes, terminal guidance (IR), AF program;
uglas, THOR and ZEUS vehicles and support services; A. D. Little,
erations analysis. DESCRIPTION: Consists of both NIKE-ZEUS
d THOR-AGENA w/terminal stage programs; intercepts have been
complished at "hundreds of miles," according to Secretary McNamara.
ATUS: Operational, according to DOD.

M I (Navy)

No contractor announced. DESCRIPTION: Longer-range, smaller anti-
liation missile than SHRIKE for armament of F-111B and A-7A aircraft.
ATUS: Development funds requested in FY '67; also $4 million asked for
M technology beyond ARM-I; interim system possible using new seekers
other air-launched missiles such as AIM-47A, BULLPUP, SPARROW and
proved SHRIKE.

ROC (RUR-5A) (Navy)

Honeywell, prime; Sangamo Electric, sonar; GE, torpedo; Librascope-
enerol Precision, fire control. DESCRIPTION: ASW, surface-to-under-
ter; weight, 1,000 lbs.; solid propulsion; warhead, nuclear or conven-
nal torpedo; range between 1,800 yds. and 8 mi.; guidance, unguided.
ATUS: Operational on DE, DD, DLG, & heavy cruisers; one "live"
apon fired in 1962 Pacific nuclear tests; extended-range version in pre-
gram definition phase; version adaptable to TERRIER launchers being
veloped; FY 1966 procurement to complete Navy's stock needs; new
ds requested for a significantly longer range version compatible with
isting launcher and fire control.

MARC B (AIM-10B) (Air Force)

Boeing, prime; General Precision Aerospace/Westinghouse/IBM,
dance; Thiokol/Marquardt, propulsion. DESCRIPTION: Surface-
air; weight, 16,000 lbs.; solid booster/ramjet propulsion; warhead,
clear; range, more than 400 n.mi.; guidance, command via SAGE;
ed, Mach 2.7. STATUS: Three bases operational; production com-
ted; the 188 B models will be distributed among the eight bases after
A model is phased out; all A missiles at five bases operational in
theastern U.S. phased out by the end of FY 1965.

LLPUP (AGM-12 B & C) (Navy-Air Force)

Martin, systems cognizance; Maxson Electronics Co., production;
okol, liquid and solid propulsion; Naval Propellant Plant, solid pro-
sion (motor loading). DESCRIPTION: Air-to-surface, range, 3-6 mi.;
dance (visual reference), radio-link command. BULLPUP A: Solid
pulsion; warhead, 250-lb. H.E. BULLPUP B&C: pre-packaged liquid
tor; warhead, 750-lb. H.E. STATUS: BULLPUP A deployed with
antic and Pacific Fleets; operational with U.S. Air Force & NATO
ts; training version (ATM-12) being procured by both services; being
duced in Europe for NATO; procurement of larger warhead version
both Navy & AF renewed with FY '66 supplemental.

APARRAL (Army)

A surface-to-air adaptation of the Navy's air-to-air SIDEWINDER;
unted on vehicles, in a 4- or 6-missile configuration. Philco's Aero-
ronic Div. is prime; CHAPARRAL will be an interim, fair-weather-only
ution to forward-area air defense; has been successfully fired; produc-
n increased substantially; more battalions formed. (See: SIDEWINDER.)

NDOR (AGM-53) (Navy)

Naval Ordnance Test Station project; North American Aviation,
lumbus Div., prime contractor. DESCRIPTION: Air-to-surface TV-
ded, stand-off weapon; range, 40 mi. STATUS: Development funds
uested in FY '67; intended for use with Navy version of F-111 and an
5 aircraft.

VY CROCKETT (M-388) (Army)

In-house project directed by Army Weapons Command at Rock Island,
DESCRIPTION: Surface-to-surface; solid propulsion, bazooka-
nched; warhead, sub-kiloton nuclear; guidance, free flight; two
nchers—vehicle-mounted or carried by two men. STATUS: Opera-
nal in Europe.

TAC (MGM-32A) (Army)

Nord Aviation, prime. DESCRIPTION: Anti-tank; weight, 37 lbs.
h launcher; solid propulsion; warhead, shaped-charge H.E.; range,
00 ft.; guidance, wire-guided; man-portable. STATUS: Operational;
curement complete; will be replaced by TOW.

LCON (AIM-4A, C, E, F/26A/47A) (Air Force)

Hughes, prime; Hughes, guidance; Thiokol, AIM-4/26 propulsion;
kheed Propulsion, AIM-47 propulsion. DESCRIPTION: Air-to-air;
ight (AIM-4/47), more than 100 lbs. — (AIM-26), more than 200
.; range 5 n.mi.; supersonic; solid propulsion; warhead, H.E. (except
AIM-26B, which carries nuclear warhead); AIM-4A, and 4E, active
or homing guidance; AIM-4C, and 4F, IR homing; AIM-26 model
nuclear warhead and hybrid IR radar homing. STATUS: Operational
-out of 4E, 4F and 26 in FY '62; AIM-47 is the armament for YF-12A
-11); several versions operational on F-101, F-102 and F-106.

GENIE (AIR-2A) (Air Force)

Douglas, prime; Aerojet-General, propulsion. DESCRIPTION: Air-to-air; weight 800 lbs.; unguided; solid propulsion; warhead, nuclear; range, 6 n.mi.; guidance, free flight; supersonic; proximity fuzing. STATUS: Procurement complete; operational on F-101B and F-106; improved version cancelled; launcher being developed by McDonnell for adaptation to F-4 aircraft.

HAWK (MIM-23A) (Army)

Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion. DESCRIPTION: Surface-to-air; weight, 1,275 lbs., solid propulsion; warhead, H.E.; range, 22 mi.; guidance, semi-active radar homing; 100-45,000-ft. ceiling; provides defense against medium and low-flying aircraft and cruise-type missiles. STATUS: Operational; deployed in Europe, Panama, Okinawa, South Vietnam, U.S. (13 battalions); bought by Sweden and Israel; R&D being conducted to adapt selected HAWK units to an anti-tactical ballistic missile; NATO producing; Japan also buying; FY '66 procurement increased for Vietnam replacement; new improvement program requested in FY '67; self-propelled version also under development; large-scale buy by Saudi Arabia; sales to other Arab nations include Iran, Iraq and Lebanon.

HIBEX (ARPA/Army)

Boeing, prime; Hercules and Aerojet, propulsion. DESCRIPTION: Experimental program in high-energy propellants; cone-shaped missile; performance classified; solid propulsion. STATUS: Development; accelerations of 800 to 1,000 g's goal; static test of motor successful November, 1964; flight test program of 10 vehicles being conducted at WSMR; third successful flight Oct. 28 was first from underground cell at WSMR; Up-Stage program started to add second stage and increase range; evaluation now underway of recent flights in conjunction with HAPDAR phased-array radar.

HONEST JOHN (MGR-1A) (Army)

Douglas/Emerson Electric, prime; Hercules, propulsion. DESCRIPTION: Surface-to-surface; weight, 5,900 lbs.; single-stage solid propulsion; warhead, nuclear; range, 12 mi. (M-31), 20 mi. (M-50); unguided. STATUS: Operational; M-50 being deployed in Europe; to be replaced by LANCE; procurement complete.

HOUND DOG (AGM-28) (Air Force)

North American, prime; Autonetics, guidance; Pratt & Whitney, propulsion. DESCRIPTION: Air-breathing air-to-surface standoff missile; weight, 9,600 lbs.; turbojet propulsion; warhead, nuclear; range, about 600 n.mi.; guidance, all-inertial; ceiling in excess of 50,000 ft.; Mach 2+. STATUS: Operational; to be launched from B-52G intercontinental bombers; procurement complete; new terminal guidance being developed.

LANCE (XMGM-52A) (Army)

LTV Aerospace, prime; Systron-Donner, guidance. DESCRIPTION: Highly mobile general-purpose missile; very light weight; pre-packaged storable liquid propellant; warhead, nuclear and H.E.; range, 70 km; guidance, Automet inertial, one missile per launcher. STATUS: Initial procurement in FY '67, with large scale production likely; eventually will replace HONEST JOHN, LACROSSE and perhaps LITTLE JOHN; division support weapon; may also replace some tube artillery; to use multi-system test equipment; Navy requests $2 million for start on new "Landing Force Support Weapon" using sea-based LANCE.

LITTLE JOHN (MGR-3A) (Army)

Emerson Electric, prime; Hercules Powder, propulsion. DESCRIPTION: Surface-to-surface; weight, 800 lbs.; solid propulsion; warhead, nuclear; range, 10 mi.; unguided, supplements medium and heavy artillery in airborne divisions and air-transportable commands. STATUS: Two battalions activated in 1961; each equipped with four launchers; air- and helicopter-transportable; may be replaced by LANCE.

MACE (MGM-13A, CGM-13B) (Air Force)

Martin, prime; Goodyear/AC Electronics, guidance, Thiokol/Allison, propulsion. DESCRIPTION: Air-breathing surface-to-surface; weight, 18,000 lbs.; turbojet and solid propulsion; warhead, nuclear and H.E.; range, over 650 n.mi. (Model A), over 1,200 n.mi. (Model B); guidance, map-matching (A), inertial (B). STATUS: Five MACE-A and one MACE-B squadrons (in hard sites) deployed in Europe; two MACE-B squadrons on Okinawa in hard sites.

MAW (Army)

McDonnell Aircraft Corp. version of Medium Anti-Tank/Assault Weapon selected for development. DESCRIPTION: Surface-to-surface; solid propellant, range, 500-1,500 yds.; shoulder-fired; wire-guided; weighs about 30 lbs. STATUS: Full-scale development will begin in FY '67; studies will continue of possible use of some techniques from Army Missile Command version.

MAVERICK (AGM-65A) (Air Force)

No prime yet. RFP's expected this month. DESCRIPTION: New tactical air-to-surface missile with TV guidance similar to WALLEYE but for different type targets.

MINUTEMAN (LGM-30) (Air Force)

TRW Systems Group, systems engineering and technical direction; Boeing, major contractor; Autonetics, guidance, Thiokol, first-stage propulsion; Aerojet, second-stage propulsion; Hercules, third-state propulsion; Avco, re-entry vehicle; GE, MARK 12 re-entry vehicle, also Avco MK 17 re-entry vehicle beginning in 1968 aboard MINUTEMAN II. DESCRIPTION: 2nd-generation ICBM; weight, over 65,000 lbs.; solid propulsion; warhead, nuclear; 3 stages; range, 7,000 mi.; guidance, all-inertial, target selected in seconds; 32-sec. reaction time. STATUS: First 10 MINUTEMAN II's operational since October; at least 200 operational by end of FY '67 to complete 1,000-missile force; 800 MINUTEMAN I's now operational; advanced version can be fired by airborne command posts; deployed in hardened and dispersed silos; all MINUTEMAN I missiles to be replaced by MINUTEMAN II in phased replacement program costing $1 billion; MMII has greater accuracy (nearly 8 times more) and range-payload than I version; MINUTEMAN III, with advanced re-entry vehicle probably maneuverable and carrying multiple warheads, will be procured initially in FY '67; new third stage to be developed for III version; advanced ICBM, called IMPROVED CAPABILITY MISSILE (ICM) may get OK in FY '68.

NIKE-HERCULES (MIM-14B) (Army)

Western Electric, prime; Western Electric, guidance; Hercules and Thiokol, propulsion; Douglas, airframe. DESCRIPTION: Surface-to-air, anti-aircraft, tactical; weight, 10,000 lbs.; solid propulsion; warhead, nuclear or H.E.; range, 75 mi.; guidance, command; Mach 3+; ceiling in excess of 150,000 ft. STATUS: Over 80 batteries deployed in U. S. being turned over to National Guard; over 10 N-H batteries deployed overseas; Japan plans additional procurement; being equipped with HIPAR, a high-power acquisition radar, and anti-tactical-ballistic-missile capabilities. Re-location of some HERCULES batteries under consideration by JCS.

NIKE-X/Zeus (XLIM-49A) (Army)

Western Electric, prime; Bell Telephone, guidance; Thiokol/Lockheed, propulsion; Douglas, airframe. DESCRIPTION: Anti-missile missile, 3-stage; weight, 22,800 lbs.; solid propulsion; warhead, nuclear; range, 200-mi.; guidance, command; length, 48 ft.; diameter, 36 in.; fin span, 10 ft. STATUS: Missile is now part of NIKE-X missile "mix"; development, except as part of X, has ended; no intercept "failure" in more than a year of tests; advanced version of ZEUS (DM15X2) now under development reflects important breakthrough in long-range (400-mi.) ICBM interception.

NIKE-X (Army)

Western Electric, prime; Bell Telephone, guidance; Thiokol, ZEUS propulsion; Douglas, ZEUS airframe; Martin Marietta, SPRINT missile prime; Hercules and Lockheed, SPRINT propulsion. DESCRIPTION: Successor to ZEUS as an anti-ICBM system; uses a mix of ZEUS/SPRINT missiles and multi-function array radar (MAR). STATUS: Engineering development; funded at $447 million in FY '67 on accelerated development schedule, but deployment still deferred; full system tests to be conducted this year from Kwajalein Is. with new modular radars; deployment cost: $8-20 billion depending on version; more optimism seen for light-attack version.

PERSHING (MGM-31A) (Army)

Martin, prime; Bendix, guidance; Sperry Farragut, fuzing and aiming; Thiokol, propulsion. DESCRIPTION: Surface-to-surface; weight, 10,000 lbs.; two-stage solid propulsion; warhead, nuclear; range, approx. 400 n.mi.; guidance, inertial; transported on FMC M474 tracked vehicles; replaced REDSTONE. STATUS: Flight test program completed; troop firings from Ft. Wingate, N.M., to White Sands being conducted; number of missile-loaded launchers per unit to be increased; West Germany organizing two battalions; first U. S. PERSHING battalion deployed to Germany in April, 1964; new modification program to improve reliability and rate of fire.

PHOENIX (AIM-54) (Navy)

Hughes Aircraft Co., prime; Rocketdyne, propulsion. DESCRIPTION: 1,000-lb. air-to-air missile for use with the F-111B fighter aircraft; each aircraft will be able to carry six missiles; missile control system designated AN/AWG-9; and missile/bomb launcher is MAU-48A. STATUS: Development; first flight test planned in March, 1966 but program has slipped substantially because of continuing development problems and Navy uncertainty over F-111B; first guided flights early '67.

POLARIS (UGM-27 A, B, C) (Navy)

Lockheed, prime; GE/MIT/Hughes/Honeywell/Raytheon, guidance and fire control; Aerojet-General/Hercules, propulsion; Lockheed, re-entry vehicle; Nortronics, checkout; Autonetics/Sperry, SINS; Westinghouse, launching equipment; Vitro, systems engineering coordination and training; Systron-Donner, ignition programming. DESCRIPTION: Underwater- and surface-to-surface; weight, 30,000 lbs.; solid propulsion; warhead, nuclear; range, 1,200 n.mi. (A-1), 1,500 n.mi. (A-2), 2,500 n.mi. (A-3); guidance, all-inertial. STATUS: 29 subs operational each with 16 A-2 or A-3 missiles; all A-1's now retired; total of 41 POLARIS subs authorized; to be operational by FY '68, includes 13 with A-2, 28 with A-3; British to buy A-3 missiles from U.S. POSEIDON, follow-on FBM, now in full-scale development; same contractors as POLARIS except for propulsion—Hercules/Thiokol first stage; Hercules second stage; same range as A-3 with double payload and accuracy; 50-month development effort; may go aboard 19 subs; PenAids and warhead can be field-changed; FY '67 funds are $300 million; total program costs are $1.3 billion.

QUAIL (ADM-20C) (Air Force)

McDonnell, prime; McDonnell, electronics, guidance; GE, propulsion; TRW, Inc., ECM equipment. DESCRIPTION: ECM-carrying decoy, which simulates B-52 bomber to enemy radar; turbojet powered; range, 250 mi.; guidance, gyroscopic autopilot. STATUS: Deployed at SAC bases; carried by B-52; procurement completed FY '61; advanced version with 400-mi. range has been flight tested.

REDEYE (XFIM-43B) (Army)

GD/Pomona, prime; Atlantic Research, propulsion; MPB, Inc., seeker optics. DESCRIPTION: Surface-to-air; weight, 28 lbs.; solid propulsion, warhead, conventional; guidance, IR homing; length 48 in.; diameter, 2.75 in. STATUS: Production; tests against helicopters and jets at NOTS successful.

REGULUS I (RGM-6) (Navy)

LTV Aerospace Corp., prime; Sperry, guidance; Allison, propulsion. DESCRIPTION: Surface-to-surface; weight, 14,000 lbs.; turbojet and solid propulsion; warhead, nuclear; range, 500 n.mi.; guidance, inertial; speed, about 600 mph; ceiling, approx. 40,000 ft. STATUS: Five REGULUS subs with 17 missiles are operational now; 3 subs (8 missiles) phased out in FY '65.

SAM-D (Formerly AADS-70) (Army)

Eleven firms hold bid requests; proposals due JUNE 14; RFP's went to GE, Raytheon, Hughes, RCA, Westinghouse, Boeing, Sperry Rand, Sylvani ITT, Litton, and General Dynamics. DESCRIPTION: Field army aircraft/missile defense system, mobile. STATUS: DOD approved Army go-ahead for CDP; full-scale development on accelerated basis approved for FY '67 missile will replace both HAWK and NIKE-HERCULES; production could cost more than $2 billion.

SERGEANT (MGM-29A) (Army)

Sperry Utah, prime; Sperry, guidance; Thiokol, propulsion. DESCRIPTION: Surface-to-surface; weight, 10,000 lbs.; solid propulsion; warhead, nuclear; range, over 75 n.mi.; guidance, inertial; uses drag brakes. STATUS: Operational procurement complete; deployed in Europe.

SHILLELAGH (MGM-51A) (Army)

Philco Aeronutronic, prime; Picatinny Arsenal/Amoco Chemicals Corp. propulsion; Aeronutronic, guidance; Martin Co., second production source. DESCRIPTION: Surface-to-surface; lightweight; solid propulsion; warhea nuclear or H.E.; guidance, command; vehicle-mounted for use against fie fortifications, armor and for close-in support of troops. STATUS: Large-scale production; second-source procurement expected; to use multi-syste test equipment; to be installed on Gen. Sheridan assault vehicle; also bei considered for use on helicopters; Philco has contract to adapt missile to Army's M-60 tank.

SHRIKE (AGM-45A) (Navy)

Naval Ordnance Test Station-China Lake, prime; Texas Instruments, guidance and control; North American Rocketdyne (McGregor), propulsion. DESCRIPTION: Air-to-surface, anti-radar; solid propulsion; guidance, passive radar homing. STATUS: Operational with Navy and Air Force but many problems; advanced version under accelerated development and will probably be bought by AF and Navy; Army also looking at laser-guided version.

SIDEWINDER 1-C (AIM-9C&D) (Navy, Air Force)

Naval Ordnance Test Station, technical direction; Philco, IR guidance, Motorola, radar guidance; Naval Ammunition Depot, McAllister, motor loading; Rocketdyne (McGregor), propellant. DESCRIPTION: Air-to-air; weight, about 185 lbs.; solid propulsion; warhead, H.E.; range, more than 2 mi. STATUS: 1-A and 1-C deployed with Navy and Air Force; NATO-built version in production. (See CHAPARRAL.)

SPARROW III-6B (AIM-7E) (Navy)

Raytheon, prime; Raytheon, airframe, control, guidance; Aerojet-General/North American Rocketdyne (McGregor), propulsion; McDonnell/Benrus Watch Co., launcher. DESCRIPTION: Air-to-air; weight, 350 lbs.; solid propulsion; warhead, conventional; range, 5-8 mi.; guidance, semi-active CW homing; Mach 2.5-3; ceiling, over 50,000 ft. STATUS: Operational with Navy and AF aircraft; SPARROW III-6B prime armament for Phantom II (F-4B) and other high-performance interceptors; Italians buying NATO version for use on new F-104S; sales to West Germans and other NATO F-104 consortium memmers possible; advanced version under development for Navy; Navy also to develop SPARROW as point defense missile system for shipboard air defense.

SPRINT (Army)

Martin-Orlando, prime; Hercules Powder/Lockheed Propulsion Co., propulsion; Bell Telephone Laboratories, guidance. DESCRIPTION: High-acceleration cone-shaped maneuverable missile for low-altitude interception of ballistic missiles; 4.5-ft. base diameter, 27 ft. long; two-stage; nuclear; missile will be popped out of silo before motor is ignited; to be part of the missile mix in a NIKE-X battery. STATUS: Development; first flight in March, 1965, tested vehicle aerodynamically; successfully tested from silo Nov. 17 at WSMR; extensive guidance tests underway; tests to move to Kwajalein in 12-18 months for use with NIKE-ZEUS and full radar system.

SRAM (Air Force)

Boeing and Martin Marietto won CDP awards of $2.75 million each. DESCRIPTION: Air-to-surface defense-suppression stand-off missile for use with F-111 and possibly B-52, B-58 or the Advanced Manned Strategic Aircraft; nuclear and conventional warhead. STATUS: Accelerated development in FY '67; $40 million requested; contractor selection expected in August.

STANDARDIZED MISSILE (Navy)

No contractors. DESCRIPTION: Fleet air-defense missile to replace TARTAR-TERRIER and give Navy a single missile to perform both missions; longer-range targets (30+ miles) would be engaged by adding a booster to the shorter-range (10+ miles) weapon; similar to the homing TERRIER now being procured. STATUS: Development; production funds requested; intended to work with new TARTAR-D digital fire control.

SUBROC (UUM-44A) (Navy)

Naval Ordnance Laboratory, technical direction; Goodyear, prime; General Precision Aerospace, guidance; Thiokol, propulsion; General Precision Libroscope, fire control. DESCRIPTION: Underwater-air-underwater anti-submarine missile depth bomb; solid propulsion; warhead, nuclear, weight, 4,000 lbs.; length, 21 ft.; diameter, 21 in.; range, 25-30 mi.; guidance, inertial. STATUS: Operational evaluation completed, now being deployed on Permit-class submarines.

SS-10 (MGM-21A) (Army)

Nord Aviation, prime. DESCRIPTION: Surface-to-surface, primarily anti-tank; weight, 33 lbs.; solid propulsion; warhead, conventional; range, 1,600 yards; wire-guided. STATUS: Operational with U.S., French and other NATO and Western units; bottle-tested in North Africa; U.S. replacing with ENTAC.

SS-11 (AGM-22B) (Army)

Nord Aviation, prime. DESCRIPTION: Surface-to-surface anti-tank, also helicopter-to-surface; weight, 63 lbs.; solid propulsion; wire-guided; warhead, conventional; range, 3,800 yds. STATUS: Operational, used with airborne units and Army helicopters; AS-12 being considered by Navy for ASW aircraft.

TACTICAL PROBE (Navy)

Bendix, prime: DESCRIPTION: Surface-to-air; multiple, interchangeable payloads for each mission; booster, TERRIER or TALOS from shipboard installations; high-impulse second stage; range, 50-300 mi.; parachute descent. STATUS: Program definition; a new study has been authorized, and is under way, to evolve a cheaper program.

TALOS (RIM-8E) (Navy)

Bendix, prime; Vitro, systems engineering; McDonnell/Hercules Allegany Ballistics Lab., propulsion; Sperry, guidance; GE, launching gear. DESCRIPTION: Ship-to-air; weight, 7,000 lbs.; solid and ramjet propulsion; warhead, nuclear; range, 65 n.mi.; guidance, radar beam riding/semi-active homing; Mach 2.5. STATUS: Operational aboard cruisers Galveston, Little Rock & Oklahoma City and three Albany-class DEG's; Long Beach, nuclear-powered cruiser, has advanced TALOS; "3-T" get-well program intended to improve reliability; procurement continuing.

TARTAR (RIM-24B) (Navy)

Vitro, systems coordination engineering; Applied Physics Lab, design and development; GD/Pomona, Aerojet-General, propulsion; Sperry Farragut, fuze (target detection device). DESCRIPTION: Ship-to-air; weight, 1,500 lbs.; solid dual-thrust motor; warhead, conventional; range, 10 n.mi.; guidance, semi-active homing; Mach 2. STATUS: Operational; installed aboard 23 guided missile destroyers and three cruisers equipped with TALOS; get-well program progressing; no additional missile buy.

TERRIER (RIM-2E) (Navy)

Vitro, systems engineering; GD/Pomona, prime; GD/Pomona, guidance section; Sperry, radar; Hercules Allegany Ballistics Laboratory, propulsion; Northern Ordnance, launching gear. DESCRIPTION: Ship-to-air; weight, 3,000 lbs.; 27 ft. long; solid propulsion; warhead, conventional; range 10 n.mi.; guidance, radar beam-riding or homing; Mach 2.5. STATUS: Operational aboard two attack carriers, 6 cruisers, and 12 missile frigates; get-well program progressing; being used in test firings against surplus REDSTONE missiles; no additional missile buy.

TITAN II (LGM-25C) (Air Force)

Martin, prime; TRW Systems Group, systems engineering and technical direction; AC Electronics, guidance; Aerojet-General, propulsion; GE, re-entry vehicle. DESCRIPTION: ICBM; weight, 330,000 lbs.; N_2O_4 and Aerozine-50 storable fuels; warhead, nuclear; range, over 5,000 mi.; guidance, inertial; 115 ft. long; 2 stages; greatest payload and range of any U.S. ICBM, basic core vehicle for TITAN III booster. STATUS: All 54 missiles operational in 18-missile squadrons at Davis-Monthan AFB, McConnell AFB, and Little Rock AFB.

TMRBM (Air Force)

No contractors announced, but probably would be some team producing the second and third stages of MINUTEMAN II. DESCRIPTION: A transportable mid-range missile to fill the gap left by cancellation of MMRBM; it would use the top two stages of MM II and the MM II guidance system; would weigh more and be less mobile than MMRBM, but could be developed for approximately one-third the cost; reaction time also less than MMRBM's; employment concept much the same as that of the Russian-deployed missiles in Cuba in 1962. STATUS: Study by the Air Force at DDR&E direction; not likely to be developed due to a lack of mission.

TOW (XMGM-71A) (Army)

Hughes, prime. DESCRIPTION: Anti-tank; weight, 160 lbs.; solid propulsion; warhead, H.E.; wire-guided; optically tracked; tube-launched. STATUS: Development; follow-on to ENTAC; successful firings have been conducted; helicopter use planned.

WALLEYE (Navy)

Martin Co., prime; NOTS development; TV-guided glide bomb with good stand-off range; large buy expected for AF and Navy; smaller version, called SNIPE, under NOTS development for Army helicopters.

ZUNI (Navy)

Naval Ordnance Test Station, prime; Hunter-Douglas, propulsion. DESCRIPTION: air-to-surface; weight, 107 lbs.; solid propulsion; warhead, conventional; range, 5. n.mi.; unguided. STATUS: Operational; designed for use on jet fighter and attack aircraft; big increase in orders because of Vietnam war.

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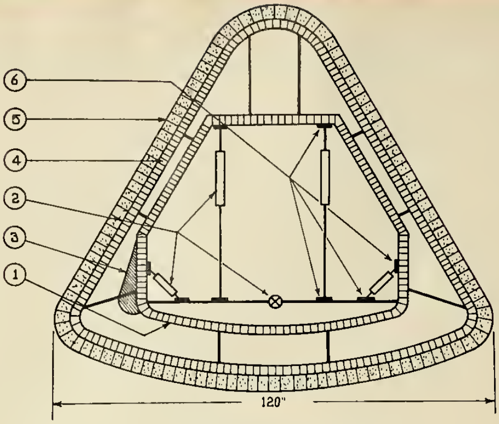

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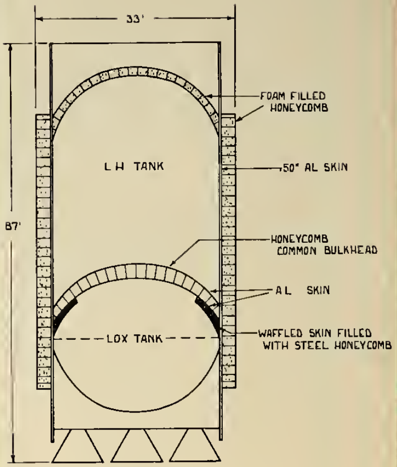

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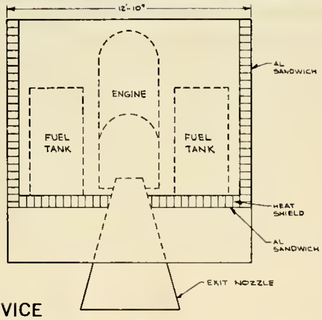

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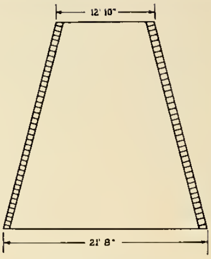

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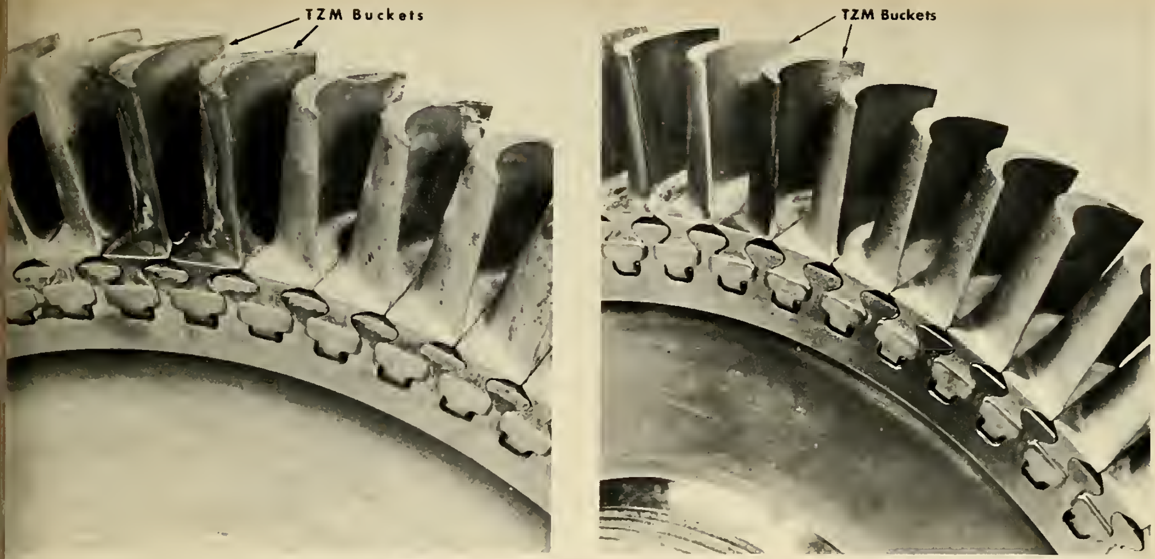

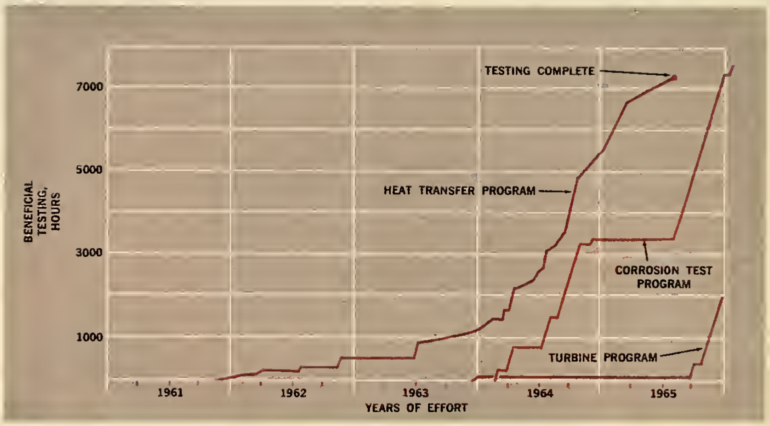

OP LEFT: Photo of forward face of sec-
nd-stage turbine wheel after 2,000-hr. run
hows very little actual erosion. TOP
IGHT: Same area after removal of stains
y vapor blasting. Small nick on one blade
vas caused by installation damage, not ero-
ion. Erosion found could be eliminated in
ll-refractory metal system, since GE re-
earchers feel stainless-steel elements con-
ributed heavily. RIGHT: Total beneficial
esting in heat transfer, turbine and cor-
osion test loop programs since inception
f work at GE. Huge amounts of data are
ow being analyzed while GE experts plan
ther experiments in all areas to more
ompletely define design, materials and en-
lurance factors of dynamic space-power
onversion systems based on Rankine cycle.

(Continued from page 23)

henomenon with respect to the ma-
erials under consideration.

SPPS tackled the design of electro-
nagnetic pumps from the mechancial
nd electrical approach and came up
vith a ten-fold weight improvement.
EM pumps have been made by GE for
nore than 17 years and one unit has
perated in excess of 2,500 hours at
luid temperatures of 1,900° to 2,000°F
n a materials loop at the GE facility.

The lightweight design uses nickel-
obalt magnetic materials and high-tem-
erature inorganic winding insulators.
The improvement program is NASA-
unded and led to three major conclu-
ions.

These are that a specific weight 1/10
hat of conventional EM pumps is pos-
ible with currently available materials;
EM pumps, especially the induction
ype, should exhibit excellent cavitation
characteristics because the pumping
ction is the result of body forces gen-
rated within the fluid, and flow control can be obtained over the full range of flow capability with no tendency to stall at very low flow.

Vapor chamber radiator—A proprietary capillary boiler-pump structure using a wicking action is the key to the GE-designed radiator. The concept is an application of the vapor chamber fin or heat pipe device.

The approach cuts 50% from the weight of more conventional radiator designs and adds the benefit of modular functions. Thus discrete particle penetration knocks out only that small section perforated.

The concept has been in the works since 1961 at GE and tests have been run from 40° to 1,500°F using water, potassium and sodium as the working fluids.

In operation, heat transfer is accomplished through the mechanisms of vaporization of an internal working fluid at one end of the fin duct, flow of the generated vapor down the length of the duct, condensation of this vapor on the duct heat sink surfaces and refluxing of the condensate back to the heat input surfaces.

The wick structure is attached to the heat input surface and handles both the vapor generation function. It also supplies the necessary pressure rise to motivate the two-phase flow that accounts for the heat transfer.

In zero-g operation, the boiler-pump sucks the refluxing condensate stream through suitably designed capillary channels. Condensate formed on the radiation-cooled surfaces is concentrated by surface tension into these refluxing channels.

The design work on this concept has reached the point of establishing proven design procedures for vapor fins applicable to high-temperature space radiators.

Zipkin is convinced his group could move faster than current funded programming indicates. Yet he points out that the technology is such that the next step, which now looks relatively simple, may prove to be as tough as all the work to date. ■

Firms Urged To Diversify While Defense Spending High

by William S. Beller

WASHINGTON—Companies wanting to diversify into commercial business as a hedge against eventual defense cutbacks, or possibly as a way to increase profits, should start now when defense spending is high.

Researchers looking into problems of diversification for the defense industry also strongly advise management of defense firms to seek the advice of experts who thoroughly know the commercial marketplace before venturing into it.

Unfortunately, it is "particularly inconvenient" for defense firms to try to penetrate alien markets now, when the demands of the defense customers are heavy. Nevertheless, if payoffs from diversification are going to be needed to take up the slack when arms spending drops off, company managers must make their commercial plans now, researchers at the Denver Research Institute (DRI) stress in a recently released study.

The DRI work was sponsored by the U.S. Arms Control and Disarmament Agency in order to forecast the economic adjustments the defense industry may have to make if demand for military products is drastically reduced. One solution suggested by John S. Gilmore and Dean C. Goddington, chief writers of the DRI report, calls for the Federal Government to actively encourage diversification of the defense industry "if preparation for (arms) cutbacks is deemed to be in the public interest."

Specifically, the writers recommend that the Government look into modifying the Armed Services Procurement Regulations (ASPR) "to make various diversification costs allowable expenses under defense contracts." Replying to a MISSILES AND ROCKETS query about this suggestion, a Dept. of Defense spokesman concerned with policy and ASPR said noncommittally, "The Government is always eager to see such proposals from industry and will consider them if they have merit."

On the other hand, Dr. J. Herbert Hollomon, Assistant Secretary of Commerce for Science and Technology, was far more outspoken, telling M/R that the companies making up the defense industry are private organizations and decisions as to whether or not to diversify and how to do so are "purely private."

Hollomon: "No moral or ethical principle" involved.

Hollomon, however, stressed that he was speaking only for Commerce and not for any other Government agency, such as Defense, which may have reasons of its own to encourage a diversification plan.

Premise questioned—Hollomon is not convinced that defense spending will drop sufficiently in the foreseeable future to place the defense industry as a whole in economic trouble. This opinion was seconded by a highly placed DOD official. Yet many equally knowledgeable experts see no alternative to a large cutback in defense spending once the Vietnam war is settled unless a number of new strategic or other major weapons systems such as *Nike-X* are readied for the U.S. inventory or another U.S.-involved conflict arises.

Hollomon agreed with the DRI findings that if a defense company wants to diversify, its best procedure is to "find somebody who knows about commercial business." However, he pointed out, "There is no moral or ethical principle that says a defense company has to diversify or that it is good for that particular company—but it may be."

Top management program—A company will not be able to diversify successfully without the active interest and even participation of its top management. The DRI report emphasizes this point over and over again, and lists three factors that make a top-management commitment difficult to get:

—A discouraging history of failure in commercial diversification efforts by defense firms.

—Doubt that the defense customer would approve of diversification efforts.

—Not much indication that stockholders of defense firms or the financial community want defense companies to diversify.

Yet there are examples of top-management interest and commitment resulting in successful diversification. The DRI report detailed some of these—including the work of Glen Robinson, president of Scientific-Atlanta, whose "personal efforts" resulted in his firm's substantially increasing its non-defense sales volume. The head of Barnes Engineering Co. "spends considerable time in the laboratory and working with a number of hospitals around the country" to develop and market the company's medical thermograph.

In 1959 and early 1960, Lockheed Aircraft Corp. embarked upon a major diversification program which led it to buy a number of large companies. These included Puget Sound Bridge & Dredging, Stavid Electronics, and Grand Central Rocket (now Lockheed Propulsion Co.). Robert Gross, then chairman of the board, "gave active personal leadership to Lockheed's diversification efforts at that time," but since his death in 1961, "Lockheed has not made a significant acquisition," the DRI researchers observed.

Ways to diversify—The fastest way to enter a commercial market is to buy a company already in it. That this route is often successful is evidenced by the competition large companies are encountering in their pursuit of good commercial firms. Yet the experience is not necessarily profitable. Lockheed discovered this when Puget Sound Bridge and Dredging, in the black when it was

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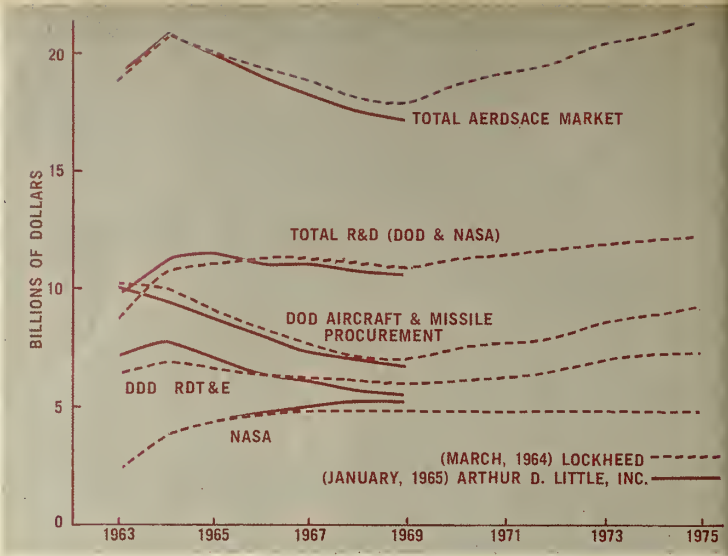

Two estimates of the prospective market for aerospace firms through Fiscal 1975.

bought, went into the red about $8 million through 1964.

In looking back over the acquisition, Dudley Brown, Lockheed group vice president, felt that his company had not given enough thought to the internal changes required in an acquired firm, according to the DRI writers. They quote Brown as saying, "In the future, we will project the organizational and administrative requirements of an acquisition for at least two or three years into the future."

A slower way to diversify—but one offering management a higher profit relative to investment and greater control—is through internally developed products and services. The DRI study verified that this method takes time, and "few instances were turned up . . . where a new product was able to break even in less than five years."

Internally developed products and services fall into three types among the firms DRI studied. In the first type, new uses are found for a company's existing products. An example of this procedure involves Pratt & Whitney Aircraft Co.'s J-57 jet engine, used on the B-52 bomber and other aircraft. In what was said to be the first non-aircraft application of the turbojet engine, the J-57 was modified for use as a stationary powerplant and put into operation in October, 1960. It was used in combination with a Cooper-Bessemer Corp. compressor to push natural gas through a transmission line near Clementsville, Ky.

A second approach to internally developed products for commercial use calls for redesign or additional development of existing products for the nondefense market. The Cubic Corp., f
instance, in 1960 introduced an ele
tronic distance-measuring device call
the Electrotape, which measures t
time required for a radio wave to trav
to and from the point being measure
and could be useful for surveyi
work. The technology for this produ
was an outgrowth of the company
military work.

In 1964, Cubic's sales of surveyi
products were approaching a millio
dollars annually (up 47% from 196
and were primarily to consulting e
gineering firms, state and local go
ernments, and foreign countries. T
Electrotape system sold for $12,000

A third way to develop produc
without company acquisition is
produce a new product to meet a d
fined market need. The Garrett Corp
industrialization of the gas turbine e
gine as a total energy package for lar
buildings is an example.

By invasion—All these methods i
volve an innovating spirit by the d
fense company. The company ente
an unfamiliar market with an improv
product, or invades the market of
different industry as chemical co
panies moved into the textile mark

Assistant Secretary Hollomon, co
menting on the invasion of the marke
place by an alien industry, says it
lustrates the fact that institutions wi
a large commitment to the status q
find it difficult to change very quick
or very drastically. This is where
defense company has its opportunit
The invading company has very litt
investment, either material or em
tional, in the traditional way of fab
cating a product, or distributing a pro

uct, or in the traditional raw materials, or sources of supply, according to Hollomon.

Thus, the invader or innovator has very little to lose, compared to the well-entrenched firms in the industry. This conclusion presupposes that the defense company has the ability to analyze the commercial market, prepare for it, and successfully sell to it. That these attributes are not universal was illustrated by a letter sent by the president of one defense company in answer to DRI's request for information:

> Gentlemen:
>
> Thank you for your interest in our (diversification) activities. All we can say at the moment is that we have lost so much money to date that we can't afford to take the time to give you a full report.
>
> Sincerely . . .

Ways to turn—The defense industry has many attributes that could lead to successful commercial diversification. It knows how to sell to governments. It has highly sophisticated facilities available, and analytical skills able to solve problems of vast scope. It has managers used to dealing with high-risk ventures and possessing the requisite capital. Moreover, it is an industry used to meeting performance standards rather than product standards.

In naming these advantages, Hollomon suggested that the defense industry should itself determine what commercial markets are possible. Sales to governments, domestic and foreign, are "of course" indicated, he said. Also, sales to large industries such as the oil industry—but not to the supermarket consumer.

Possible fields—In particular, Hollomon suggests that interested companies consider the problem of the country's transportation systems. "Simulation, safety research and practice, traffic control systems, analysis of transportation problems on a national scale—these are only a few of the problems which will loom even larger in the years ahead," he said.

The medical and biomedical fields are only now beginning to appreciate the contributions that can come from the physical sciences and engineering, said Hollomon.

He named the field of education, where classroom television is only "the first crude step in the application of engineering concepts to the process of teaching." There are additional opportunities in the classification, storage and display of information, and in handling the ever-increasing amount of clerical work faced by teachers. ■

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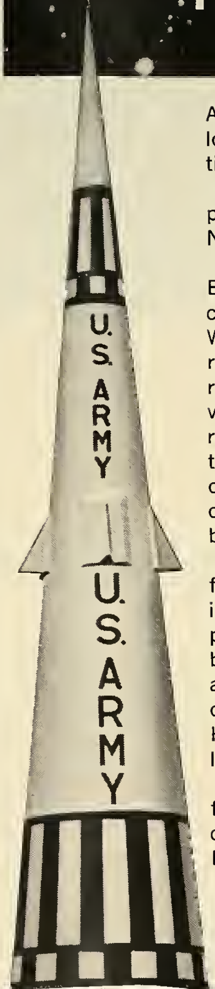

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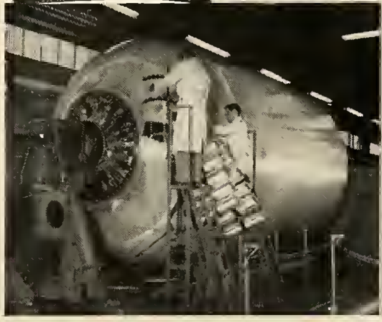

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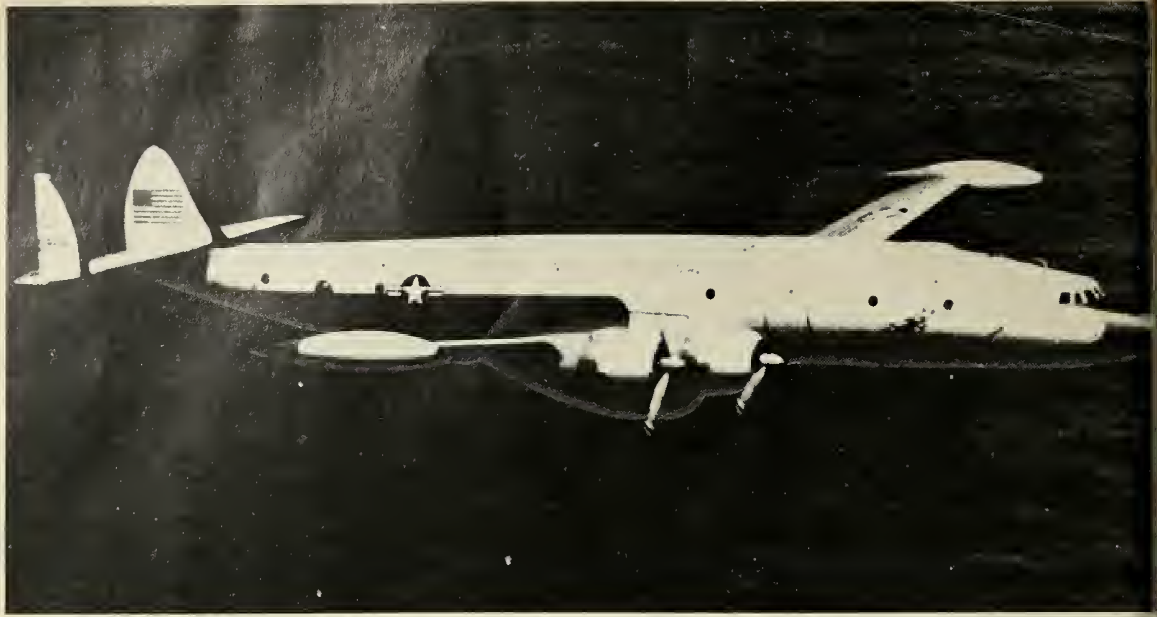


C-121 aircraft of the type being used to chart northern wall of Gulf Stream

OCEANOLOGY

Gulf Stream Wall Charted for ASW

by Robert W. Niblock

WASHINGTON—The northern wall of the Gulf Stream is being tracked on a scale never before attempted by the aircraft unit of the U.S. Naval Oceanographic Office, using a Super Constellation equipped with an airborne infrared radiation thermometer.

The Navy aircraft, one of several in the Oceanographic Air Survey Unit based at Patuxent River (Md.) Naval Air Station, is assigned to the Antisubmarine Warfare Environmental Prediction Service (ASWEPS), an Oceanographic Office project now in the test phase which will provide day-by-day forecasts on ocean conditions to ASW task forces at sea.

According to John C. Wilkerson, one of four oceanographers assigned to the aircraft unit, the current project is important to the Navy oceanographic effort because the Gulf Stream is the major thermal feature of the North Atlantic.

For ASW purposes, he said, it is desirable to know the Stream's location and how fast it moves laterally, as well as its temperature features. The Oceanographic Office daily prepares sea-surface temperature charts which are distributed to the fleet on facsimile broadcasts.

The information gathered on the flights also may help oceanographers answer basic questions about the Gulf Stream, which has aroused scientific curiosity since it was first charted by Benjamin Franklin in 1770.

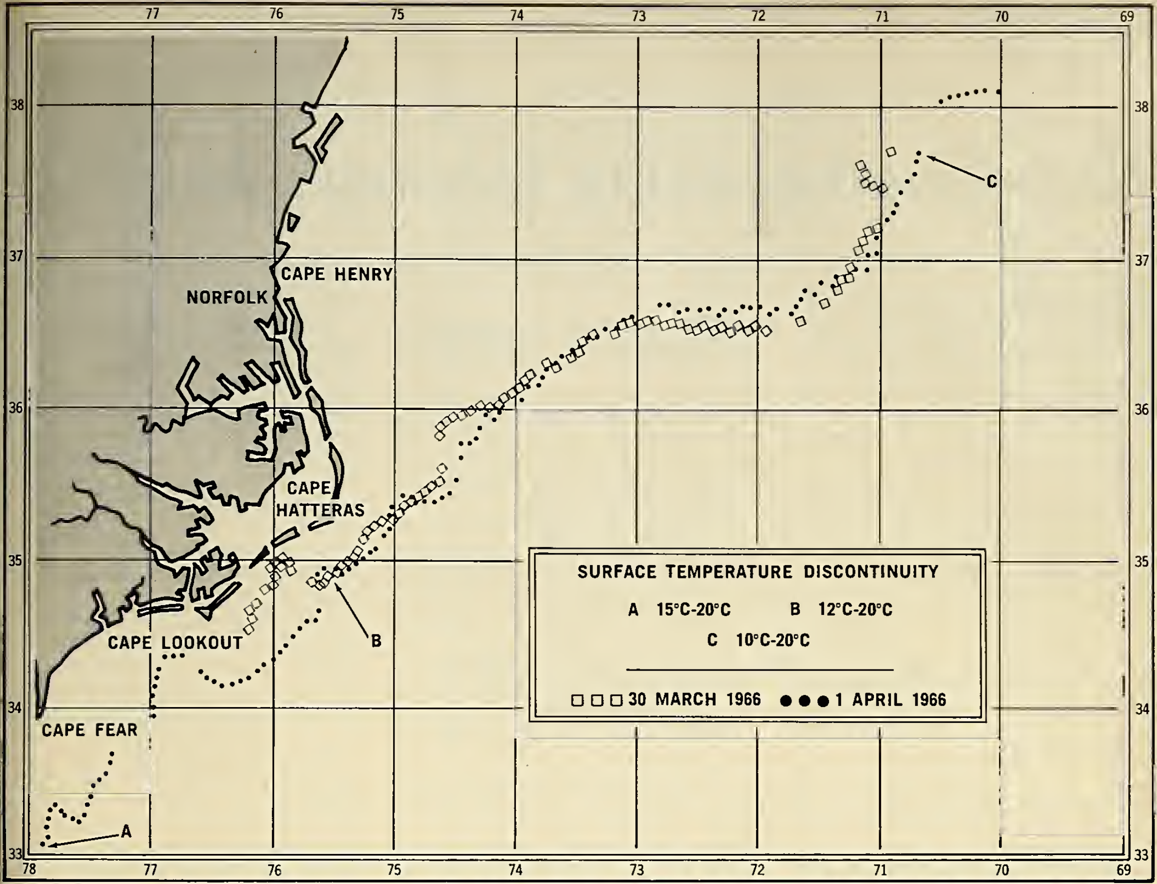
Searching for pattern—Tracks plotted from the data gathered to date show the Gulf Stream (actually called the Florida Current south of Cape Hatteras) bending and twisting sharply, quite like a river, during its passage from the southeastern tip of Florida to a point somewhat north of Hatteras where the twists and bends elongate and increase in size. The movement, says oceanographer Robert Pickett of the aircraft unit, is probably caused by the relatively shallow water along the Florida coast and the land barrier of the coastline. As the current flows north of Hatteras, it moves into deep water with no confining barriers.

The oceanographers also are trying to determine a pattern to the movement of the thermal line, or interface, between the cold northern water and the warm water. If the tracking data reveals that the interface continuously passes through node points—and the precise location of these nodes can be fixed—then they could with more certainty predict the location of the interface and the Gulf Stream itself on a given day.

Regular flights are planned for the rest of the year and the scientists will keep extending the flight times, now about 3-4 hours. The NC-121K Super Constellation could stay over the meandering current for 20 hours.

To facilitate the difficult task of keeping the aircraft on the 17°C isotherm—the average spring temperature of the interface—a meter in parallel with the airborne radiation thermometer (ART) was installed in the pilot's compartment. The pilot attempts to hold the plane on a course corresponding to the 17° temperature reading.

Ships have long recorded sea-surface temperature over the Gulf Stream and Oceanographic Office aircraft have measured the current's temperature while crossing it during the past several



Course of the northern border of Gulf Stream, being tracked to aid ASW task forces.

years. The advantage of this new technique, says Wilkerson, is that it makes it possible to get a "snapshot" of long stretches of the current for a given day.

In following the 17° isotherm, the plane flies midway between the cold Labrador Current water pouring down from the north and the upward-moving, warm Gulf Stream water. The task is most difficult along the southern U.S. coast because the water is warmer and the temperature delineation is not visible from the air. When they move farther northward, the translucent blue of the Gulf Stream in contrast to the murky Labrador Current water gives the pilot a visible line to follow.

Large schools of fish, turtles and whales have been spotted during the flights along the cold wall where the food is plentiful, and marine biologists will be observers on some of the future flights.

How ART works—The ART on the aircraft was built by Barnes Engineering Co. of Stamford, Conn. The model (14-320) uses a thermistor bolometer—an instrument which measures infrared intensity—with optical filters that limit the incoming radiation to 8-13 microns. The absolute temperature of the sea surface is measured by comparing radiation emitted from the sea surface to a "blackbody" of known temperature—50°C in this case.

The laboratory accuracy of the ART is plus or minus 0.2°C over its operating range of —2°C to 35°C. Flight altitudes for using the ART are 200-1,800 ft. and accuracy drops to plus or minus 0.4°C because of atmospheric attenuation. At 1,000-ft. altitudes, the ART is able to measure an ocean area 40 x 40 ft.

Ideal weather conditions are needed for the flights, since the ART cannot be operated in rain or fog. Also, a wind of about 10 knots is required before the water is sufficiently mixed to obtain a representative reading of sea-surface temperature. The instrument measures only a thin surface skin about the thickness of a dollar bill.

Twenty on team—The actual tracking job is a team effort, requiring split-second accuracy and coordination. About 20 men—including pilots, navigators, crewmen, enlisted aerographer's mates and an oceanographer—make each flight.

Most crucial is having precise navigational data; otherwise the temperature readings are worthless. Using LORAN A, a position was plotted each minute during the first two three-hour flights. Senior navigator Lt. Randolph Watson, USN, has three men under his command. The four work in two-man teams, one taking a LORAN A reading, while the other team is plotting the positions.

Aerographer's mates under Navy Lt. William Dehn at the Oceanographic Office monitor the instruments and plot the temperature data. Wilkerson, Pickett and two other oceanographers—Edward Khedouri and Gary Athey—rotate turns for the flights.

Having the read-out for the ART in the cockpit serves the dual purpose of helping to maintain course and directly involving the aviators in the actual oceanography, says Wilkerson. "I think they are just as excited about the project as we are," he added.

The plane commander is Lt. Cmdr. James Odee. ■

New Cinetheodolite Enhances Accuracy

by David A. Anderton

HOBOKEN, N.J.—A unique cinetheodolite capable of detecting a ½-in. object at a slant range of 100,000 ft. has been developed by Keuffel & Esser, Inc., for the Army's White Sands (N.M.) Missile Range.

Basis of the system is the definition of its geometry by optical, rather than mechanical means. Uncertainties are very much less for optical than for mechanical measurements.

The Keuffel & Esser unit, described for MISSILES AND ROCKETS by George Shiba of the company's Optical and Mechanical Division, has an accuracy of two seconds of arc, or about eight parts in a million. A WSMR study of the best foreseeable accuracy obtainable with a mechanical geometry of advanced design showed that mechanical errors could not be reduced below about six seconds of arc, plus the errors inherent in measuring that angle, plus the errors in measuring azimuth and elevation references.

The K & E cinetheodolite resembles a standard phototheodolite mounted on a cylindrical base. The objective lens of the tracking telescope has a 12-in. aperture and a 120-in. focal length. It can be slewed at a maximum velocity of 40 degrees per second, and at a maximum angular acceleration of 30 degrees per second per second.

The concept of the new unit grew out of the need for improved position accuracy in measurements of missile trajectories.

System advantages—Historically, most of the data gathered at WSMR has come from its Askania cinetheodolite system. There are several reasons for this, starting with the fact that the transplanted German scientists who helped establish the range had used cinetheodolite systems for tracking on the Peenemünde range.

Beyond this, however, the cinetheodolite inherently is an instrument capable of accuracy and precision. Used on an overland range such as White Sands, it can be located at optimum stations almost without regard to terrain. The shorter-range missiles characteristically fired from, or along, an overland range pass through most—if not all—of their critical phases within sight of a cinetheodolite system.

Such a system also has passive detection capability. The size of the smaller missiles generally limits the amount of active instrumentation that can be carried. Optical means of detection can supplement this limited equipment and provide position data with generally greater accuracy than electronic gear.

A study of future cinetheodolite requirements conducted in the Range Instrumentation Development Division at WSMR concluded that the cinetheodolite can continue as a primary source of trajectory data, assuming that advances in the state of the art make it possible to develop a unit with higher accuracy and precision.

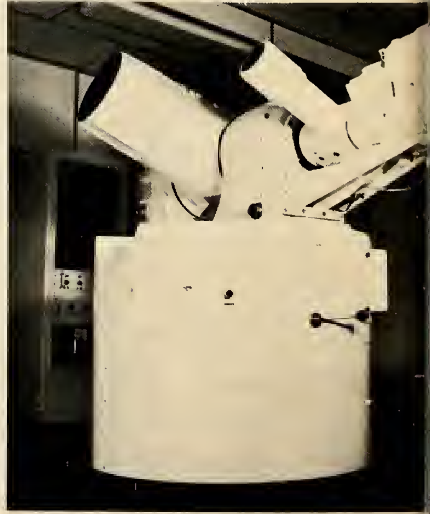
Limitations—These latter constraints grow out of the range mission. As missiles get smaller and faster, they become progressively harder to define in terms of velocity and position data. Their size and speed make it mandatory to have better data in order to establish their trajectory parameters with even the same degree of accuracy as currently achieved. And if higher orders of precision are demanded, then the measurements must be refined still further.

The White Sands study concluded that future optical tracking systems should be capable of producing reliable data up to an altitude of 100,000 ft. with an accuracy of eight parts per million, or about two seconds of arc.

By using multiple stations for tracking and producing data, accuracy requirements for individual instruments can be relaxed somewhat. Consequently, the original design goal considered by WSMR was 10 parts per million per instrument.

Other constraints on the design of the system were imposed by the need to measure a large number of firings per day, often at very short intervals. This demands a long recording time, and the capability to complete one run and be ready to start another within a minimum of time. Recording film magazines

LEFT: George Shiba, of Keuffel & Esser, Inc.'s Optical and Mechanical Division, shown looking into open end of 12-in.-aperture objective lens of K&E's new tracking cinetheodolite. RIGHT: Complete mount with objective lens and pointing telescope used by operator is shown without three racks of electronics that are associated with the system in operation. FAR RIGHT: Drawing shows optical path of light ray from source to film plane.



have to be capable of pull-out/plug-in replacement.

Tracking velocities are determined by the type and velocity of missiles being fired. The worst case—requiring maximum angular velocity—would be for a launch observed by the nearest station, perhaps on the order of one mile away. That figure was determined to be about 35 deg. per second. The minimum rate of velocity would, of course, be zero.

The concept and preliminary design of the WSMR cinetheodolite were evolved within these constraints.

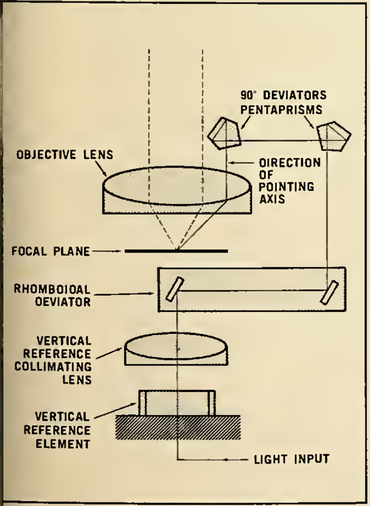
Zero errors—Even though an optical reference system can be shown to have the low errors demanded by the requirements, there is no point in building such a system unless it can be constructed independently of mechanical errors.

Optical flats, lenses, mirrors, and prisms all have to be held mechanically in some kind of a structure, and the whole design is to no avail if that structure can introduce errors in the optics.

There are a number of possible ways to obviate errors. The final arrangement, one of several that were studied, uses four groups of optical flats. Three of these are deviator units and the fourth is the vertical reference.

These combine to transmit a reference light beam to the focal plane which is receiving the image of the tracked missile through the objective lens. The reference light beam is split into four beams whose average is taken as the direction of the pointing axis for reference. The four beams show as four light spots in the photographed image of the missile and the data references. Those spots are used to establish the pointing axis, using standard film data-reduction techniques.

The light beam originates below the vertical reference element, a glass mushroom that floats on an air bearing.


90° DEVIATORS
PENTAPRISMS
OBJECTIVE LENS
DIRECTION OF POINTING AXIS
FOCAL PLANE
RHOMBOIDAL DEVIATOR
VERTICAL REFERENCE COLLIMATING LENS
VERTICAL REFERENCE ELEMENT
LIGHT INPUT

■ Pratt & Whitney Aircraft has openings in both Connecticut and Florida for qualified men who want to pit their knowledge and accumulated experience against a variety of complex heat transfer and compressor design problems. Positions are available at various levels, and we invite inquiries from the recent engineering graduate as well as from those with advanced degrees and considerable related experience.

heat transfer

■ Specific problems include analytical design and development evaluation of: Transient temperature analysis of complex gas turbine structures; High pressure cryogenic and storable fuel rocket engine systems: Convective heat transfer over a wide range of flow conditions; Analysis of engine lubrication and fuel systems involving conventional and high energy fuels; Compact heat exchanger design; Transpiration, film regenerative and ablative nozzle film, regenerative and ablative nozzle cooling; Turbine blade and vane cooling.

compressor design

■ Current problems include the design and development of supersonic airfoils, high-lift airfoils, extremely small gas turbines for space use and high Mach number, high pressure ratio turbofan stages. Other investigations involve research on unsteady aerodynamics in rotating machinery, aerodynamically excited vibration and boundary layer effects and control in rotating machinery.

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A

Laboratory technician holds collimator lens, which maintains verticality of collimated beam regardless of its own tilt and produces parallel light beam.

The upper surface of that mushroom is an optical flat, which is flat within one wavelength of light. The stem of the mushroom hangs in a damping fluid, and the entire mushroom then acts like a damped pendulum. The flat remains level within 1/10 of a second of arc even if the base tilts over several minutes of arc.

Collimator—Above the vertical reference is the collimator lens, which functions simply to produce a collimated (parallel) beam of light. The lens has the unique property of maintaining the verticality of the collimated beam regardless of the tilt of the lens itself.

For example, a lens of this type has been built to maintain an accuracy of two-tenths of a second of arc over a tilt range of one degree each side of the measured vertical.

Deviators—Light leaving the collimator lens enters the rhomboid deviator, an alignment periscope which angles the beam through 90 degrees. This is another key element in the design of the cinetheodolite. Its optical properties are like those of the others; the emerging beam retains its pointing direction regardless of the tilt of the instrument.

The rhomboid deviator is critical in a construction sense. Its mirrors are, of necessity, parallel within one second of arc, Shiba told M/R. But the design must allow for the fact that these mirrors are held mechanically. The assembly is mounted at three points with no mechanical constraints on its motion. The tube is bearing-mounted to eliminate possible torques which could pro-

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Navy Reorganization Won't Affect Industry Dealings

WASHINGTON—Spokesmen for the new Naval Material Command told about 900 industrial representatives at a briefing on the recently announced Navy reorganization (M/R, March 14, p. 16) that the change would have very little effect on industry's day-to-day dealings with the Navy.

The briefing, which was jointly sponsored by the Navy and the National Security Industrial Association, was held at the Departmental Auditorium April 26.

The industrialists were told that project managers, as in the past, would represent the most "active opportunities for businessmen," and that "project managers will have fuller and more precise cognizance and control of the funds related to their projects." Funds for 11 designated projects under Chief of Naval Material (CNM) will be adjusted only by the project manager—or with the consent or order of CNM or higher authority.

Most project managers will be within the Systems Commands and nearly all will be in Washington. Some projects like *Polaris* and surface missile systems will have decentralized locations as well.

The 11 designated projects now reporting to CNM will continue to do so, although some probably will be reassigned to the six new Systems Commands.

Of the three projects now in Bureau of Ships, one will go to Ships Systems Command, one to Electronic Systems Command and one to the ASW Project. The 18 projects now handled by Bureau of Naval Weapons will go to Air Systems Command and Ordnance System Command.

Managers of the three largest Navy projects—*Polaris*, ASW systems and surface missile systems—will have smaller staffs when assigned to the Ordnance Systems Command, which will utilize some of the personnel for its tasks. These project managers, it was said, will be "less involved in detailed technical operations than in the past."

Vice Adm. I. J. Galantin, CNM, who opened the briefing, said the reason that the Navy reorganization was not as "clean and simple in structure" as those of the Army and Air Force was the fact that "the Navy is a composite warfare system." He noted that "the Navy's technological responsibilities cover" probably the widest span of "any other organization in the world," and the "Navy's fundamental weapons system—the ship—is unmatched in complexity."

uce distortion. Components are plated ith both gold and silver to reflect infraed input and to conduct the heat uniormly to eliminate local bendings or ariations, Shiba said.

Light leaving the rhomboid enters he first of two pentaprism deviators. oth of these are 90-degree deviators, ach consisting of two pentaprisms, ith one's plane reflecting surface relaced by a roof edge. Light rays passng through either section are deviated n opposite directions by the same mount; the direction of the average of hese rays becomes the reference for the orizontal axis of the cinetheodolite. his reference is independent of any lt or mechanical error in the instruent.

The light beam which entered the rst 90-degree deviator is split into wo beams in its passage through the entaprisms; they strike the second 90egree deviator and are split into four eams which strike the primary mirror f the objective lens. The average direcon of these four beams defines the ointing axis of the objective lens.

Development—The K&E system has een a long time in development, a ondition that was foreseen in the origial planning by the Range Instrumentaon Development Division. The unique roperties of the cinetheodolite required ptical and mechanical construction apabilities of the highest order. K&E as able to offer them, and received the riginal contract in October, 1961.

That covered essentially a "breadoard" construction of the system, if hat word can be applied to an optical, nstead of an electronic, developmental ig.

As the work progressed, K&E deleated some of the tasks to outside firms. he drive system, for example, was esigned by Reeves Instrument Co., arden City, N.Y. The camera was ubcontracted to Flight Research, Inc., ichmond, Va., now the Richmond ivision of Giannini Scientific Corp.

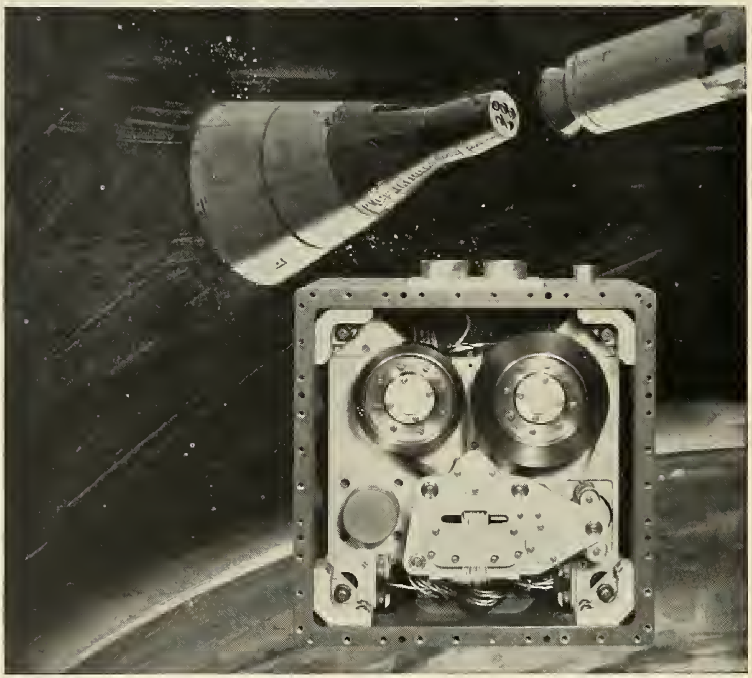
Finally, there have been some probems in the development of this unusual ystem. The effective aperture of the ointing system is very small, on the rder of an f-stop of 300. This means at the illumination supplied behind the ertical reference has to be of high innsity to register on the film in the reording camera. But this and other roblems have been solved, or are in the rocess of being solved, and the only urdle is the standard one of trials of e system in the field.

The system is designed to operate ith three units, each like the protope. Each unit will have the three racks f electronics which accompany the rototype to White Sands.

Field trials are scheduled to begin is year. ■

another space first

for a Raymond Recorder / Reproducer



Raymond ATM expands Gemini computer memory with a minimum of 1,170,000 bits of information

The successful performance of a Raymond recorder/reproducer aboard *Gemini 8* has set the stage for the day astronauts will fly a complete mission without receiving data from the ground. Built by Raymond under contract to IBM Electronic Systems Center, the 26-pound typewriter-size ATM (*Auxiliory Tope Memory*) permitted the astronauts to reload their computer with touchdown prediction and reentry instructions in flight, thus allowing greater utilization of the *Gemini* computer. With a storage capacity of 90,000 thirteen-bit words stored in triple redundancy, the ATM expands the *Gemini* computer's memory capacity by seven times.

With the ATM, future Gemini astronauts will have the capability to fly complete missions from lift-off to touchdown with little help from the ground, and test new programs such as the selection of suitable landing sites several orbits before reentry.

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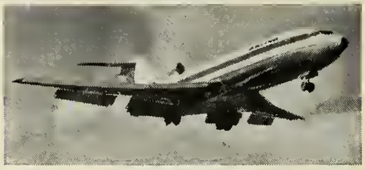
1963: 727

1966: 737

1968: 747

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The Industry Week

WESCON '66 Nears Exhibit Sellout

Exhibit space sales for the 1966 Western Electronic Show and Convention in Los Angeles have already assumed sellout proportions. Show Director William J. Moreland said that the WESCON exhibition, scheduled for Hollywood Park and the Sports Arena Aug. 23-26, will completely fill both arenas. About 600 companies have contracted for more than 1,100 of the 1,150 available exhibit booths. Space adjustments are now under study to meet the demand for additional booths. According to General Manager Don Larson, emphasis of the show will be on microelectronics and associated technologies.

Mergers and Acquisitions

Stockholders of International Telephone and Telegraph Corp., New York City, have approved the merger of ITT and American Broadcasting Companies, Inc. Under the agreement of the merger, ITT will issue 0.5719 share of common stock and 0.5719 share of preference stock for each share of ABC common stock. . . . *Lear Siegler, Inc., Santa Monica, Calif., will acquire all assets of Save Electric Corp., Toledo, Ohio. The company will operate as an independent division of LSI and continue under its present management.* . . . Marquardt Corp., Van Nuys, Calif., will sell its Pomona department's trainer and simulator business and assets to Conductron Corp., Ann Arbor, Mich., for an undisclosed amount. Terms must be approved by directors of both companies. . . . *Gulton Industries, Inc., Metuchen, N.J., has agreed to acquire all outstanding stock of United Transformer Corp., a privately held manufacturer of electronic components.* . . . Designatronics, Inc., Mineola, N.Y., has purchased for cash 100% of the outstanding stock of Perfect Gear & Instrument Corp., Northridge, Calif., manufacturers of electro-mechanical components. Perfect Gear will function as a wholly owned subsidiary of Designatronics. . . . *American Bosch Arma Corp., Garden City, N.Y., has acquired 62% of the issued and outstanding common stock of Bacharach Industrial Instrument Co., Pittsburgh, for $25 per share.* . . . Directors of Flexible Tube Corp., Guilford, Conn., and Automation Industries, Inc., El Segundo, Calif., have agreed on terms of a merger. Each share of Flexible Tube preferred stock will be convertible into 1.75 shares of Automation common stock.

New Activities

Lockheed Propulsion Co., Redlands, Calif., has established an electronic facility to measure intensity of microwave interference and noise generated by rocket motor exhaust combustion by-products. The Microwave Interference Test Facility will be the key component of Lockheed's solid-rocket exhaust plume analysis capability. . . . *Philco Corp.'s TechRep Div. has formed a documentations office in Hampton, Va. The office will be managed by Donald L. Stevens, director of TechRep's Data Systems Operation.* . . . Brown Engineering Co., Huntsville, Ala., has installed a Telemetry Systems Div. made up of its telemetry engineering and manufacturing operations. Cliff Kiley is manager of the new division; Frank Hoff has been named deputy manager. . . . *Hercules Powder Co., Wilmington, Del., has changed its name to Hercules Inc. to reflect its changing diversity of products.* . . . Monsanto Co., St. Louis, Mo., is constructing a new unit at its Monsanto, Ill., plant to increase output of paranitrochlorobenzene by 50%.

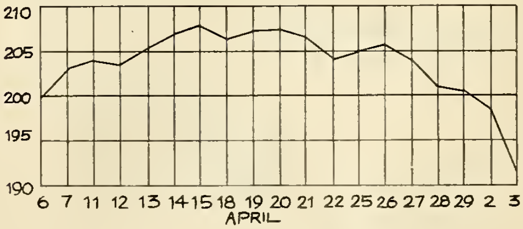
International

Planning Research Corp., Los Angeles, has reached an operating agreement with a German economic development consulting firm, Gesellschaft fuer Angewandte Planungs und Entwicklungs Forschung m.b.H. (GPE). The affiliation will expand Planning Research's economic development studies in Europe, Asia and Africa.

Industry Facilities

Philco Corp.'s Houston Operations will complete building modifications and installation of a limited-production electronics assembly plant for full operation in early May. The 8,000-sq.-ft. facility will be used primarily to produce a variety of electronics equipment for NASA's Manned Spacecraft Center. . . . *Corning Glass Works is doubling the size of its Medfield, Mass., plant. Construction of the 40,000-sq.-ft. facility will be completed by mid-summer. The Medfield plant manufactures scientific instruments and laboratory equipment.* . . . The Foxboro Co., Foxboro, Mass., has opened a large facility for assembly and calibration of industrial flow metering instrumentation. A $2-million manufacturing and office building has also been opened by the company at its Foxboro plant. . . . *American Optical Co., Southbridge, Mass., will expand its research activities in a new laboratory to be built in Framingham Industrial Park, Mass. The facility will house product-oriented research relating to the company's medical, military and scientific instrument businesses.* . . . General Electric Co.'s Missile and Space Div. has leased a 100,000-sq.-ft. building near Philadelphia. . . . *Newtek, Inc., New York City, a subsidiary of Aeroflex Laboratories, Inc., is moving to new and larger facilities in Westbury, N.Y. The firm manufactures electro-optical instruments.*

Missile/Space Stock Index



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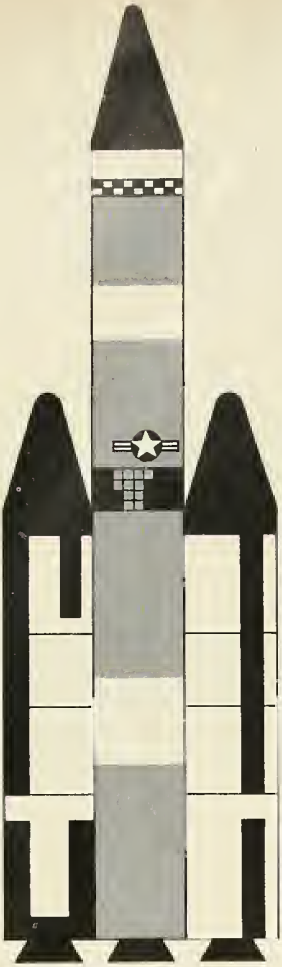

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Contracts

AIR FORCE

$13,237,000—**Avco Corp.**, Lycoming Div., Stratford, Conn., for continued production of Mark IIA re-entry vehicles for the *Minuteman II* missile.

$7,500,000—**General Electric Co.**, New York City, to continue research and development on the Mark 12 re-entry program.

$3,441,748—**Litton Systems, Inc.**, New Rochelle, N.Y., to produce spare parts for a ground-to-air communications system.

$2,069,340—**Aerojet-General Corp.**, Sacramento, Calif., for procurement of solid-propellant rocket motors for the *Athena* program.

$1,700,000—**North American Aviation, Inc.**, Los Angeles, initial increment to a contract for work in support of Air Force and National Aeronautics and Space Administration flight test programs.

$1,059,750—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif., fixed-price order for modernization of aerospace ground equipment at Vandenberg AFB, Calif.

$669,407—**General Dynamics Corp.**, Ft. Worth Div., Ft. Worth, Texas, for evaluation of penetration aids.

$270,495—**North American Aviation, Inc.**, Rocketdyne Div., Canoga Park, Calif., for engineering property data on rocket propellants. Also, $36,700 for determination of the optimum length of end release for case bonded solid-propellant motors.

$194,995—**Rocket Research Corp.**, Seattle, Wash., for evaluation of a high energy monopropellant.

$189,000—**Lockheed Propulsion Co.**, Redlands, Calif., for cyclic hydroburst test and evaluation of 156-in.-dia. case components.

$92,500—**TRW, Inc.**, Systems Group, Redondo Beach, Calif., for feasibility demonstration of a rocket engine ablative gauge.

$50,875—**Scientific Advances, Inc.**, Columbus, Ohio, to fabricate a family of connectors.

$50,800—**Thiokol Chemical Corp.**, Huntsville Div., Huntsville, Ala., for *Lance* rocket motors.

$50,000—**Dynamic Science Corp.**, Monrovia, Calif., for study of effects of additives on the combustion of hydrazine.

$36,818—**Sylvania Electric Products, Inc.**, Electronic Systems Div., Williamsville, N.Y., for design, development, fabrication and test of two UHF balloon-borne communications relay.

$31,000—**Fundamental Methods Associates**, West New York, N.J., for design, fabrication and evaluation of an electrostatic dustwall meteoroid shield.

$25,000—**Miami Valley Hospital**, Dayton, Ohio, for biochemical and physiological research for space nutrition studies.

ARMY

$8,445,257—**Western Electric Co., Inc.**, New York City, to continue research and development of the *Nike-X* anti-missile system.

$5,000,000—**Philco Corp.**, Communications and Electronics Div., Willow Grove, Pa., fixed-price contract for automatic digital message switching centers.

$1,551,818—**Gibbs Manufacturing and Research Corp.**, Janesville, Wis., fixed-price contract for 2.75-in. rocket fuzes.

$1,547,371—**KDI Corp.**, Cincinnati, Ohio., for 2.75-in. rocket fuzes.

$1,148,694—**G.E.O.** Systems, Melbourne, Fla., fixed-price contract for work on the solar vacuum telescope.

$1,443,606—**Action Manufacturing Co.**, Philadelphia, fixed-price contract for 90-mm anti-tank projectile fuzes.

$1,251,162—**Albion Malleable Iron Co.**, Albion, Mich., fixed-price contract for warheads and metal parts for 2.75-in. rocket.

$1,151,738—**FMC Corp.**, Ordnance Engineering Div., San Jose., Calif., for advanced production engineering, maintenance engineering, inspection engineering, draft manuals and prototypes for XM727 carrier-guided missile equipment.

$1,106,944—**Western Electric Co., Inc.**, New York City, for research and development services on the improved *Nike-Hercules* air defense guided missile system.

$864,578—**Hughes Aircraft Co.**, Culver City, Calif., for *TOW* heavy anti-tank assault weapons systems advance production engineering program

$750,000—**Martin Co.**, Orlando, Fla., to conduct research for the Advanced Research Projects Agency.

$500,000—**Honeywell, Inc.**, Minneapolis, Minn., for R&D and test of a three-axis laser angular rate sensor.

$387,306—**Photo-Sonics, Inc.**, Burbank, Calif., for two cine-sextant photo-optical tracking systems.

$56,536—**Raytheon Co.**, Bedford, Mass., for missile penetration aids study.

$49,800—**Philco Corp.**, Aeronutronics Div., Newport Beach, Calif., for missile penetration aids study.

NAVY

$2,102,061—**Avco Corp.**, Avco Ordnance Div. Richmond, Ind., for *Polaris* arming and fuzing devices.

$1,019,473—**Litton** Systems, **Inc.**, Westrex Communications Div., New Rochelle, N.Y., fixed-price contract for tropospheric scatter communication system.

$852,023—**Lockheed Aircraft Corp.**, Missiles and Space Co., Sunnyvale, Calif., contract modification for *Polaris* surface support equipment.

$491,173—**Vitro Corp. of America**, Vitro Labs. Silver Spring, Md., to increase level of effor for Mk 48 weapon system interface control and test program planning. Also, $470,939 for concept formulation study for a light airborne ASW vehicle.

$345,180—**Barry L. Miller Engineering, Inc.**, Hawthorne, Calif., to deliver Mark XIII mod C safety and arming devices for *Sidewinder IC*

$183,303—**System Development Corp.**, Santa Monica, Calif., for anti-submarine warfare surveillance data correlation study.

$123,615—**Radio Corp. of America**, Camden, N.J. for services to the AUTEC program.

$38,917—**Ocean Technology, Inc.**, Burbank, Calif. for feasibility studies and system analyses for advance submarine fire control system.

NASA

$1,390,347—**Sperry Rand Corp.**, Univac Div., St Paul, Minn., from Goddard Space Flight Center for programming and analysis services in support of Projects *Gemini* and *Apollo*.

$999,380—**United Aircraft Corp.**, Pratt & Whitney Aircraft Div., West Palm Beach, Fla., from Lewis Research Center for flox methane pump fed engine study.

$648,726—**Allis-Chalmers Manufacturing Co.**, Research Div., Milwaukee, Wis., from Marshal Space Flight Center, for additional experimenta research and testing work on fuel cell systems

$308,624—**Beil Aerosystems Co.**, Buffalo, N.Y. from Flight Research Center for designs and drawings for modification of lunar landing research vehicle to a lunar training vehicle Also $115,750 for lunar landing research vehicle spare parts.

$275,600—**University of Colorado**, Boulder, Colo. from Goddard Space Flight Center for ultraviolet photometer experiment for *Orbiting Geophysical Observatory E.*

$249,758—**General Electric Co.**, Missile and Spac Div., Philadelphia, from Lewis Research Cente for R&D on the pulsed plasma accelerator.

$213,015—**Stanford Research Institute**, Menl Park, Calif., for continued study of economic of solid propellant systems. Also $54,835 fror Western Operations Office for ignition of soli propellant surfaces study.

$144,000—**Cutler-Hammer, Inc.**, Airborne Instru ments Lab., Deer Park, N.Y., from Marsha Space Flight Center for improvement in con trol of automated stage checkout test conducto data system study.

$126,000—**Dynamics Research Corp.**, Stoneham Mass., from Goddard Space Flight Center fo *Apollo* range tracking vehicle program.

$99,596—**TRW, Inc.**, Systems Group, Redond Beach, Calif., from Electronics Research Cente for study of stabilization guidance and contrc design criteria definition. Also $68,000 fror Western Operations Office for reliability sup port of large solid rocket programs.

98,000—**Analytical Mechanics** Associates, Westbury, N.Y., from Electronics Research Center for trajectory analysis support for future unmanned launch vehicles.

64,885—**Air Vehicle Corp.**, San Diego, Calif., from Ames Research Center for study of nonlinear effects of very low aspect ratio lifting re-entry shapes with volumetric efficiency.

60,000—**Watkins-Johnson Co.**, Palo Alto, Calif., from Electronics Research Center for continuation of the study of active millimeter and submillimeter circuit techniques.

58,926—**TRW, Inc.**, Redondo Beach, Calif., from Marshall Space Flight Center for research study of a body-fixed three-axis inertial reference system for application of analytic platform to future missions.

53,260—**Douglas Aircraft Co., Inc.**, Astropower Laboratory, Newport Beach., Calif., contract modification from Electronics Research Center for continuation of a study on space cabin atmosphere contaminant measurement techniques.

52,854—**Hayes International Corp.**, Birmingham, Ala., from Marshall Space Flight Center for statistical analysis of wind profile data and application to large booster control.

50,400—**Beckman Instruments, Inc.**, Fullerton, Calif., from White Sands Test Facility for PCM controller.

49,759—**Litton Systems, Inc.**, Applied Science Div., St. Paul, Minn., from Headquarters for investigation of extraterrestrial dust at 140,000 ft.

42,026—**International Business Machines Corp.**, Systems Development Div., Hopewell Junction, N.Y., from Electronics Research Center for investigation of refractory dielectrics for integrated circuits.

39,897—**Medical Coaches, Inc.**, Oneonta, N.Y., from Kennedy Space Center for mobile verification laboratory.

30,067—**Atlantic Research Corp.**, Alexandria, Va., from Electronics Research Center for electromagetic interference study.

29,917—**Dikewood Corp.**, Albuquerque, N.M., from Goddard Space Flight for analytical studies and investigation of computer programs.

16,340—**General Precision, Inc.**, Librascope Group, Glendale, Calif., from Electronics Research Center for study of cold-substrate deposition of thin-film passive elements.

lanning Research Corp., Los Angeles, to develop and deliver a program analysis and testing system to provide automated procedures for analyzing and testing operational programs written for the *Saturn* launch computer complex. Amount undisclosed.

INDUSTRY

300,000—**Cleveland Pneumatic Tool Co.**, Cleveland, from **Boeing Co.**, Seattle, Wash., for equipment to be used for the Air Force advanced *Minuteman* intercontinental ballistic missile program.

500,000—**Radiation, Inc.**, Melbourne, Fla., from **Boeing Co.**, Seattle, Wash., for electronic equipment to be used in Air Force advanced *Minuteman* intercontinental ballistic missile testing.

100,000—**Heath Tecna Corp.**, Kent, Wash., from **Philco Corp.**, Aeronutronic Div., Newport Beach, Calif., for the manufacture of reinforced plastic heat shield fairings for the re-entry measurement program.

60,000—**Bendix Corp.**, Teterboro, N.J., from **Boeing Co.**, Seattle, Wash., for components to be used in the Air Force advanced *Minuteman* intercontinental ballistic missile program.

55,000—**Digital Equipment Corp.**, Maynard, Mass., from **Sylvania Electric Products, Inc.**, for two computers that will aim huge antennas when they beam the first commercial satellite communications traffic across the Pacific.

50,000—**Gibbs Manufacturing and Research Corp.**, Janesville, Wis., from **Boeing Co.**, Seattle, Wash., for development of an airborne data processing component.

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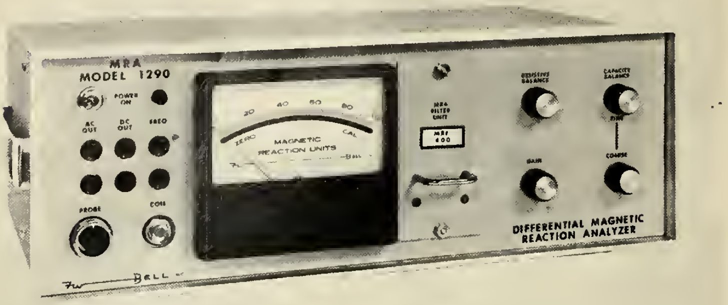

New Product of the Week: Eddy Current Tester

A self-contained differential eddy current testing instrument for high-sensitivity inspection and critical process control applications has been announced by F. W. Bell, Inc.

Model 1290 MRA is capable of operation at frequencies varying from 20 Hz to 20 KHz to provide optimum operating conditions for each combination of material properties and geometries. The instrument uses a balanced differential Hall pickup that provides high sensitivity to sharply defined discontinuities in the material and is said to be less sensitive to gradual changes in material properties and environmental conditions.

Hall elements are used as magnetic detectors. They represent point-sensitive detectors in a comparatively large excitation field, so that high resolution and low liftoff are achieved. Hall elements are not frequency-sensitive and have linear response at all test frequencies and all test speeds.

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Vacuum Coater System

A versatile, high-performance six-inch vacuum coating system has been introduced by National Research Corp.

The NRC 3177 modular coater features high-speed pumping, clean gauging and accurate manual or automatic control resulting in repeatable cycles to vacuum pressures to the 10^{-7}-torr range in less than five minutes.

Accessory options to the basic system provide a choice of performance and control to suit coating specifications. The pumping system features a six-inch diffusion pump with a speed of 2,400 liters per second, a high-conductance cold trap and a vacuum gauge located in the pumping stack.

The basic system consists of an 18-in.-dia. x 30-in.-high bell jar vacuum chamber, a base plate which accepts up to 12 feed-throughs, a complete vacuum pumping system, an ionization/two-position thermocouple gauge control, two thermocouple gauges, and one hot filament ionization vacuum gauge. A complete electrical system is included, with filament evaporation power supply and meters, a functional cabinet with central control console, and a motorized bell jar hoist.

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Scintillation Spectrometers

Two liquid scintillation spectrometers, including one capable of disintegrations-per-minute readout, have been announced by Beckman Instruments, Inc.

Models CPM-100 and DPM-100 offer analytical performance in 100-sample, ambient temperature systems. The CPM-100 provides readout in counts-per-minute. The DPM-100 offers disintegrations-per-minute and quench-corrected DPM, in addition to counts-per-minute capability.

Both systems are capable of automatic or manual counting in three separate channels, full electronic computation, and automatic external standardization. Automatic computation and printout of CPM or DPM data and 2 sigma % statistical error are featured, together with electronic computation of CPM or DPM data in both present time and preset count-sync modes, and first-minute reject for low-activity samples.

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Twin Tracking Transponders

A pair of high-performance, super-heterodyne radar transponders has been developed by the Military Electronics Div. of Motorola, Inc.

Models SST-171C and SST-181X are identical in size, weight, and dimensions, but are individually designed to operate in C- and X-band ranges, respectively. Both units are completely transistorized, except for the magnetron. The solid-state local oscillator ensures increased reliability, with lower current drain than tube-type equipments, the firm says.

The instruments have been fully qualified under environmental conditions inherent in applications in liquid- and solid-fuel rockets, missiles, and in space vehicles. They feature a solid triggering sensitivity of —70 and —6 dbm, and a power output of 400 and 350 watts minimum, respectively.

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VHF and UHF Receivers

Single-channel, all-solid-state receivers for ground-air communications systems are being marketed by Motorola, Inc.

Models CM610 and CM620 operate in the VHF and UHF bands, respectively. Frequency is changed from the front panel by switching a plug-in crystal and using front panel adjustments.

Virtual elimination of pulse interference is claimed by the firm.

Sensitivity is 1.5 mv and image rejection is 100 db minimum. A sealed pre-tuned crystal filter has a channel bandwidth of 36 kc at 6 db and 80 kc at 80 db. Audio outputs are 1 watt at 600 ohms with 5% distortion, and 10 milliwatts for headset use.

The units will operate from any nominal 115v ac (50 to 400 cps) or 28v dc source. Power consumption is less than 20 watts under maximum conditions.

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Names in the News

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William D. Brady: Joined the Missile & Space Div. of Douglas Aircraft Co., Inc., as assistant to T. W. Stephens, vice president-director.

Howard Schwartz: Appointed president and chief executive officer of the Markite Corp. and also elected a director of the corporation. He was previously a vice president of United Nuclear Corp.

Dr. Joseph J. Jacobs: Appointed to the board of directors of D. B. Milliken Co. He is president of Jacobs Engineering Co. and has been responsible for development, engineering, and marketing of many new processes and products in the chemical science industry.

Richard W. Jones: Elected a director of General Telephone & Electronics Corp. He is president of Mitchum, Jones & Templeton, Inc.

James A. Milling: Elected a director of Littlefuse, Inc. He is a senior vice president and director of the Howard W. Sams & Co.

Thomas W. Easton: Appointed divisional vice president of operations for the St. Petersburg, Fla., Div. of Electronic Communications, Inc. He will be responsible for all factory operations at St. Petersburg.

William Hines: Recipient of the 1966 Robert S. Ball Memorial Award for distinguished and meritorious space writing from the Aviation/Space Writers Association. He is the science-space editor of the Washington *Evening Star.*

Dr. Yoichiro Fukuda: Rejoined the staff of Planning Research Corp. as a senior associate in the aerospace effectiveness department. He will be engaged in the design of specialized mathematical approaches to realiability and quality assurrance testing and in the development of special-purpose reliability mathematical models.

Dr. George J. Schulz: Awarded the Davisson-Germer Prize of the American Physical Society. The award was presented for "outstanding work in the field of electron and atomic physics." He is a physicist at the Westinghouse Research Laboratories.

Louis C. Lustenberger: Elected a director of General Time Corp. He is president and a director of W. T. Grant Co.

Robert H. Roy: Elected president of the American Society for Engineering Education. He is dean of the school of engineering science at Johns Hopkins University.

Clyde M. Bellinger: Elected president and general manager of the Kurz & Root Co. He succeeds **Eugene B. Brownell,** who was named chairman of the board.

Dr. Eric A. Walker: Elected president of the National Academy of Engineering. He is president of the Pennsylvania State University and chairman of the National Science Board.

Eugene M. Kinney: Appointed vice president of special products of the Zenith Radio Corp. He will direct operations and expansion of the company's specialized electronic activities in the military, medical, and industrial fields.

George W. Herkner: Elected vice president of sales for the Warner & Swasey Co., Cleveland. He succeeds **Lester M. Cole,** who will remain as vice president to handle special assignments for the president.

Frank F. Oddi: Elected president and chief executive officer of National Co., Inc. Prior to joining the company, he was vice president of operations at Victoria Investment Co.

Edward J. Ryan: Named president of Flex-Weld, Inc. He was formerly general manager of the company.

Bryce King: Elected vice president of product development for the Brush Beryllium Co. He will be responsible for all aspects of engineering, design and development of new products applications for beryllium.

George M. Takahashi: Joined Electro-Optical Systems, Inc., a subsidiary of Xerox Corp., as senior electronic engineer in the company's physical instrumentatian group. He will supervise development of space hardware for dual EOS programs in satellite instrumentation upper-atmosphere probes.

Thomas Allinson: Appointed executive vice president and member of the board of directors of Alco Valve Co. He will direct the Industrial Products Div.

Alexander Sternberg: Named vice president of the American Society for Quality Control. He is with the Astro-Electronics Div. of the Radio Corp. of America as the manager of projects and field product assurance.

William A. Spooner: Joined Rocket Research Corp. as controller. His most recent position was with North American Aviation, Columbus Div., as a member of the administrative staff of the vice president for missiles.

Alden C. Olsen: Named vice president of sales at Cinch Manufacturing Co. Prior to joining the company, he was western regional sales manager of the ITT Cannon Electric Co.

Robert W. Morse: Named president of Case Institute of Technology. He was assistant secretary of the Navy for research and development. He was formerly chairman of the physics department at Brown University.

Herbert M. Doherty: Appointed public information manager for the Sperry Gyroscope Co. Div. of Sperry Rand Corp. **Robert S. Knapp** was named advertising manager. Doherty succeeds **Roy E. Wendell,** who resigned to join Republic Aviation Div. of Fairchild Hiller Corp.

Elwood E. Bolles: Named director of engineering at Bunker-Ramo Corp.'s Defense Systems Div. He was formerly associate director of marketing for the company and, prior to that, associate director of its information technology laboratory.

William G. Webster: Appointed vice president of the Aerospace Group of Parker-Hannifin Corp. He will continue to have marketing responsibility for the division.

Norman F. Banbury: Appointed vice president and general manager of Endevco Puerto Rico, Inc., a subsidiary of Endevco Corp. He has served as general manager of Endevco Puerto Rico since establishment of the facility in 1958.

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Third National Conference of Standards Laboratories, National Bureau of Standards, Gaithersburg, Md., May 9-12.

Ninth Midwest Symposium on Circuit Theory, sponsored by the Institute of Electrical and Electronics Engineers, Oklahoma State University, Stillwater, Okla., May 9-10.

Design Engineering Conference, sponsored by the machine design division of the American Society of Mechanical Engineers, McCormick Place, Chicago, May 9-12.

Annual Conference of Photographic Science & Engineering, San Francisco Hilton, San Francisco, May 9-13.

National Telemetering Conference, sponsored by the Institute of Electrical and Electronics Engineers, Instrument Society of America, American Institute of Aeronautics & Astronautics, Prudential Center, Boston, May 10-12.

Ninth Hydrogen Thyratron & Modulator Symposium, sponsored by the U.S. Army Electronics Command, Hexagon, Ft. Monmouth, N.J., May 10-12.

Packaging Industry Technology Conference, sponsored by the Institute of Electrical and Electronics Engineers, Hotel America, Hartford, Conn., May 10-12.

Ninth Plenary Meeting, sponsored by the Committee on Space Research, Vienna, Austria, May 10-19.

Seventh International Space Science Symposium, sponsored by the Committee on Space Research, Vienna, Austria, May 10-19.

Third Annual Symposium on Military Oceanography, San Diego, Calif., May 11-13.

Annual Symposium of the Analytical Instrument Div. of the Instrument Society of America, Shamrock Hilton Hotel, Houston, Tex., May 11-13.

13th Annual Meeting of the Society of Technical Writers and Publishers, Texan Hotel, Fort Worth, May 11-14.

Annual Meeting of the National AeroSpace Services Assn., Congressional Hotel, Washington, D.C., May 11-24.

Third Annual National Colloquim on Information Retrieval, sponsored by the computer group of the Philadelphia section of the Institute for Electrical & Electronics Engineers, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, May 12-13.

Seventh Annual West Coast Reliability Symposium, sponsored by the Reliability Div., Los Angeles Section, American Society for Quality Control, Los Angeles, May 14.

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Times of Crisis

CONGRESS ONCE AGAIN is taking on the Dept. of Defense in a major battle to force construction of nuclear-powered escort ships. Both the Joint Committee on Atomic Energy and the House Armed Services Committee are engaged in the fight.

Secretary of Defense McNamara, after a long period of opposition to Navy and Congressional desires for development of nuclear carriers during which he approved two new conventional carriers, this year agreed to construction of a second nuclear aircraft carrier, with a third to follow.

But the Secretary still opposes building of nuclear-propelled escort ships for these carriers. Against his advice, the Armed Services Committee has added funds to the budget for two nuclear frigates and directed DOD to proceed with their construction.

JCAE has just released a report of its hearing earlier this year on the Navy nuclear propulsion program. Its conclusion that progress in the application of nuclear propulsion to surface warships has been slow is a masterful understatement.

Design of the first nuclear carrier was started in 1950. The entire program was cancelled in 1953 by the Dept. of Defense, but a nuclear-powered cruiser, Long Beach, ultimately was included in the Fiscal 1957 budget and the Enterprise in the Fiscal 1958 budget. The nuclear frigate Bainbridge was included in the Fiscal 1959 program.

Of 12 major warships authorized since then, only one will have nuclear power. As the committee says: "If the two conventional aircraft carriers and the nine conventional frigates authorized since 1960 had been provided nuclear propulsion, the United States would now have in being or under construction three nuclear-powered carrier task groups instead of only one. These nuclear-powered task groups would have given the United States a much stronger Navy with which to face the uncertain and perilous future that lies ahead."

What has been the obstacle? It has been the stubborn insistence of the Dept. of Defense on cost-effectiveness as opposed to military effectiveness.

JCAE takes note of cost-effectiveness studies submitted by DOD to support its contention that nuclear propulsion is not particularly significant for surface ships. But the committee also notes the unwarranted assumptions on which these studies are based:

- That tankers and oilers needed to supply propulsion fuel for oil-fired warships will operate unhampered by the enemy and suffer no losses.
- That the fuel oil needed to run conventional surface warships will be readily available wherever and whenever needed.
- That no cost factor need be included in their studies for losses—or protection of propulsion fuel oil supply lines.

We agree with the committee when it states:

"These are dangerous assumptions to use in evaluating weapons of war. The factors of military effectiveness in the protection of our Nation's security must always be dominant over the factors of cost. In Southeast Asia today the United States is once again faced with the bitter reality that what counts in war is 'military effectiveness'—not 'cost effectiveness.' "

VICE ADM. HYMAN G. RICKOVER, U.S. Navy, Director, Division of Naval Reactors, Atomic Energy Commission, has this to say about overemphasis on cost: "The cost-effectiveness concept is good for peacetime; but the military effectiveness is what must be paramount in planning for wartime."

Adm. Rickover also is emphatic in his belief that a nuclear surface force is needed. He says: "It is foolhardy to continue not to take advantage of available technology which can keep this country strong. If important mistakes are not recognized and corrected, we may well end up with our country weakened to the point that we could not win a war if it should occur. As a case in point, consider the hiatus in building nuclear-powered surface warships. We have the technology today to build a powerful nuclear-powered naval fleet unequaled in history. But if we are confined to continuing to make paper studies rather than building ships, we may end up when a war comes with many studies and no ships."

The military advantages of nuclear power are many. Freedom from the oil supply pipeline of vulnerable tankers is one. Rear Adm. Henry L. Miller, then commander of the Enterprise, filled us in on some of the others when we were aboard his ship in the South China Sea off Vietnam. Not the least of these improvements was the freedom from stack gases and smoke, not only from the viewpoint of pilots sitting in their planes prior to takeoff or during a landing approach but also because it has reduced the maintenance bill on aircraft and communication and radar antennas. The ability to carry greatly increased supplies of ammunition and aviation gas frees the Enterprise from the need for frequent replenishment. The ability to maintain sustained high speed not only makes the carrier less vulnerable and its deployment more flexible, it enables the ship to move readily out of storm areas so that its aircraft can maintain combat operations that might otherwise have to be shut down. The Bainbridge has proven its ability to dash long distances at sustained high speeds under several critical combat conditions.

To tie a nuclear carrier to conventionally powered escorts is to reduce the military effectiveness of an entire task force. We heartily approve of the Armed Services Committee action in adding language to the authorization bill which attempts to force Secretary McNamara to build the two nuclear frigates.

As the JCAE puts it, "We must plan for times of crisis."

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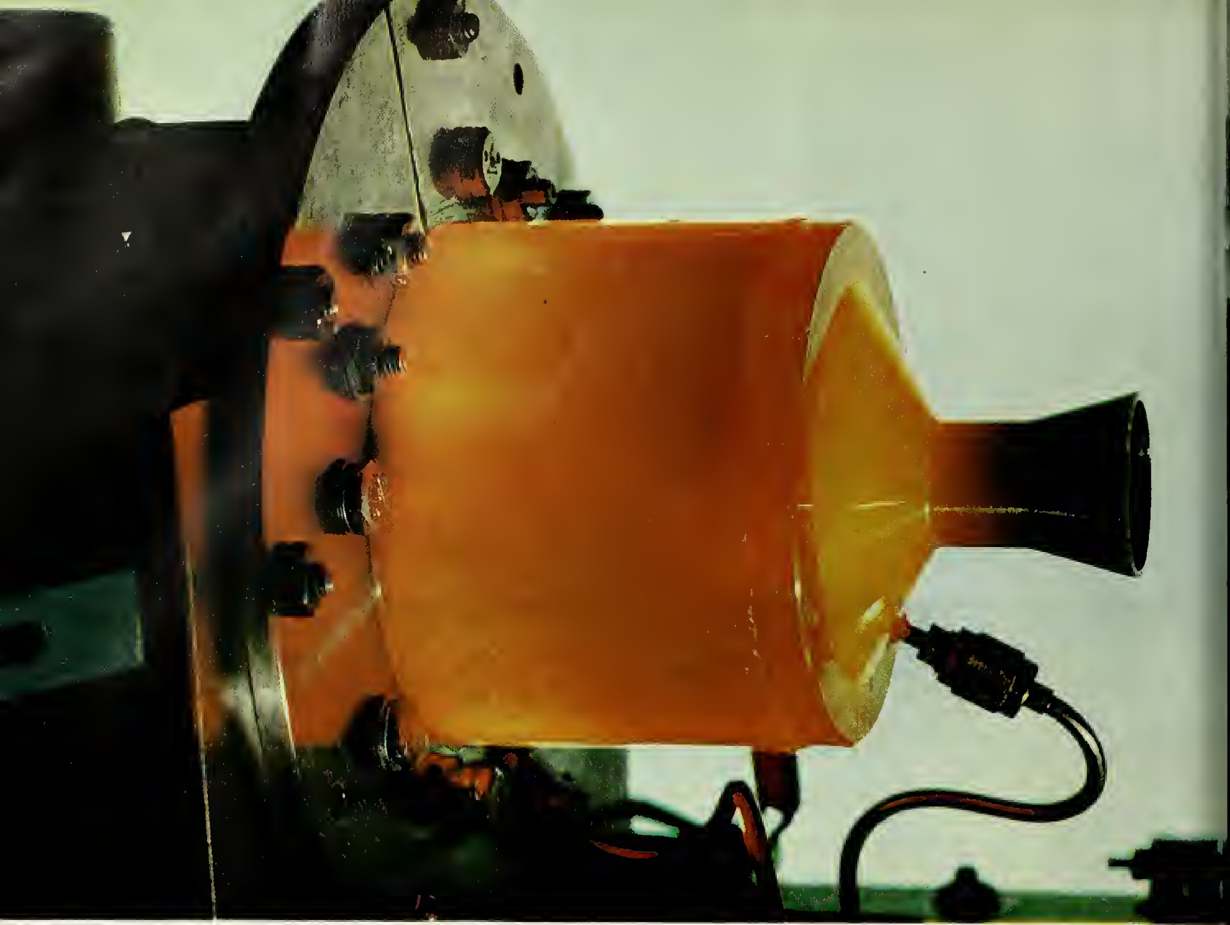

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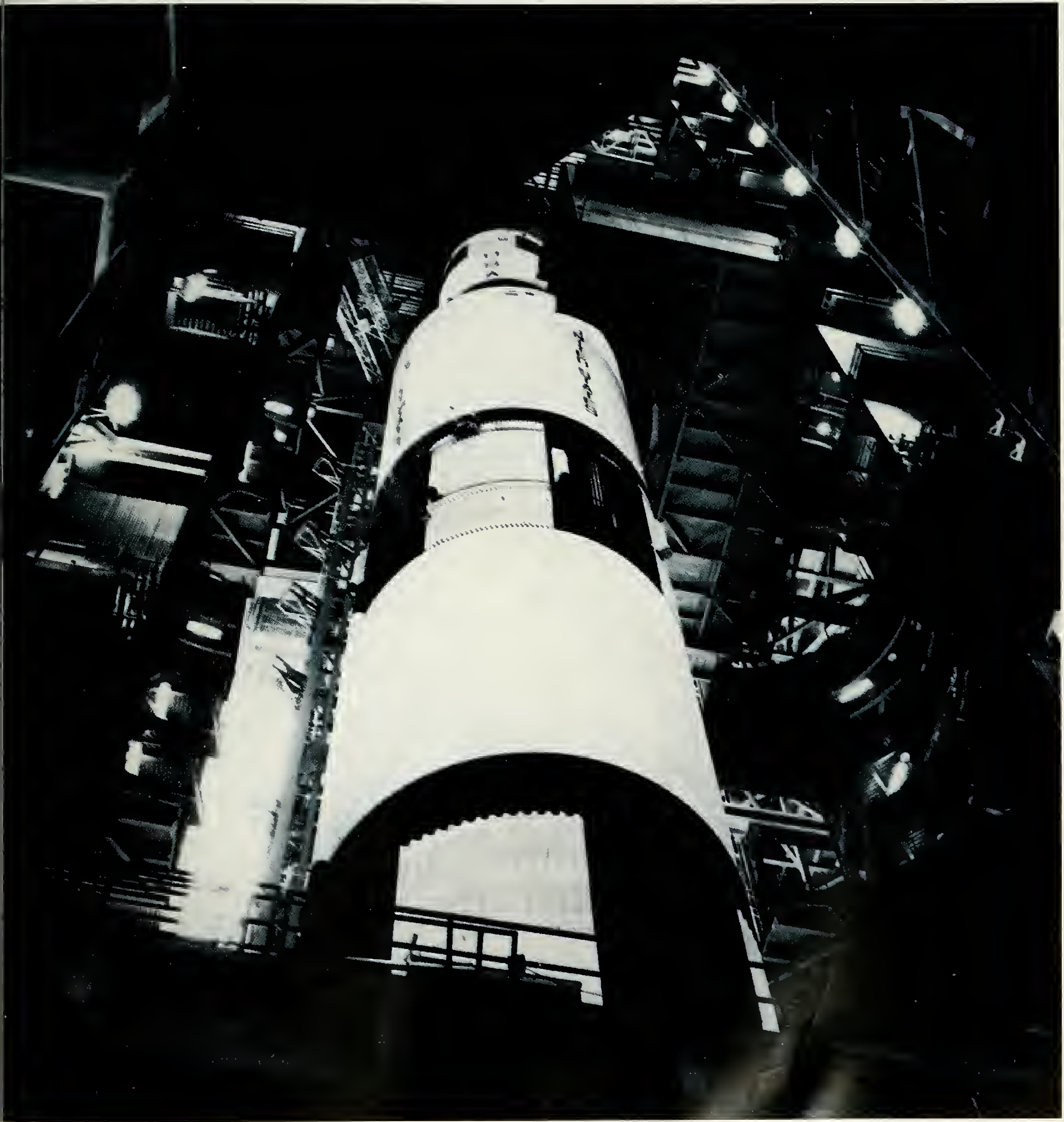

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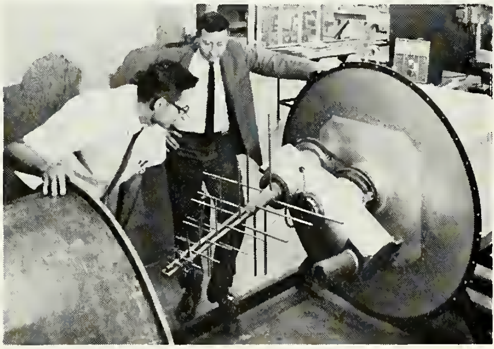

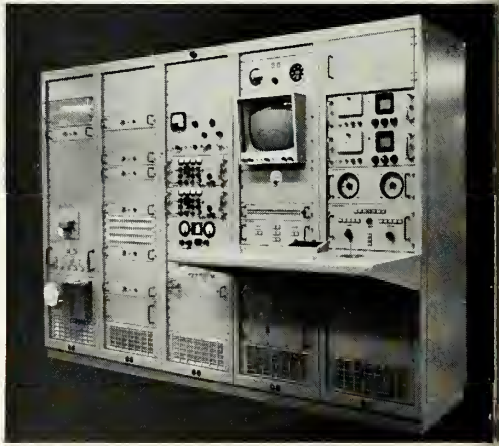

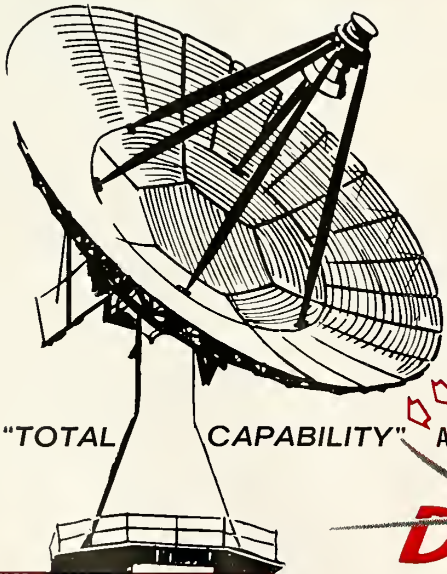

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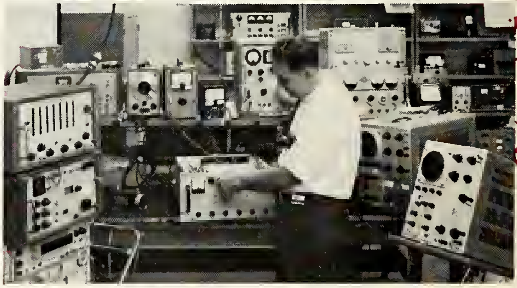

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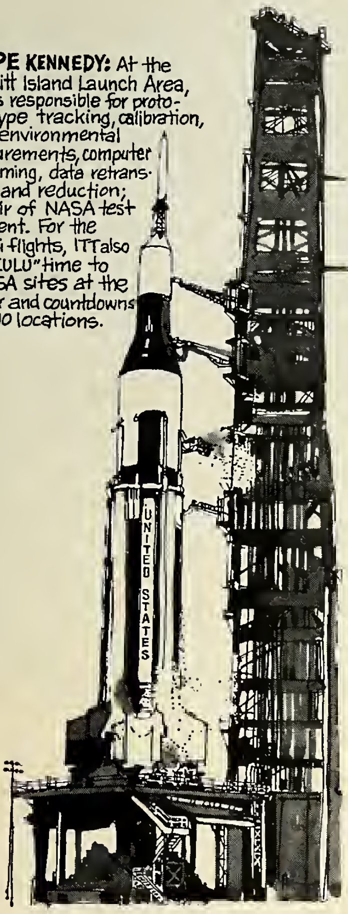

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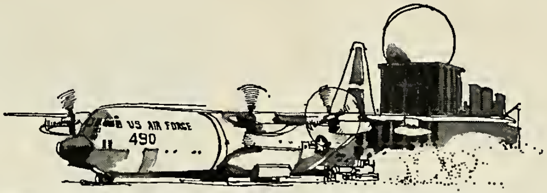

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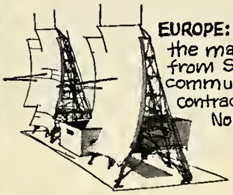
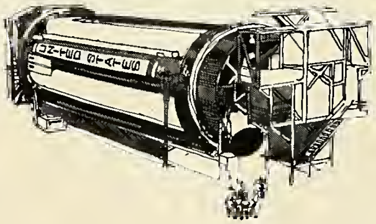


EUROPE: ITT system engineers implemented Project 486L, the massive Air Force communications system extending from Spain to Turkey; installed the U.S. Army's largest communications system (ET-A); and served as prime contractor for the ACE HIGH system stretching from Norway to Turkey.

HUNTSVILLE: At the Marshall Space Flight Center, ITT engineers perform vehicle systems checkout services on the Saturn rockets which will one day carry men to the Moon.



A few reasons why we're rarely home.

At ITT's Federal Electric Corporation (FEC) in New Jersey, where 7,600 are employed, 4,500 are on field assignments in 30 countries on all continents.

You're likely to meet ITT engineers just about anywhere—in the Arctic, Antarctic, beneath the sea in submarines, in the air—wherever there are electronic and communications systems to be maintained at optimum effectiveness.

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ITT

Catching up with Computers: A report from General Dynamics

Getting the facts faster:

Not long ago, weather satellites were transmitting hundreds of millions of bits of infrared data daily. With high-speed computers—and standard plotting techniques—fully processed data became available six months later.

By then the weather had changed.

A utility company found its customers increasingly annoyed at delays in answers to questions about their accounts. Even with its computer, by the time all records were checked, and an individual explanation written and mailed, sometimes weeks had passed.

Today, the infrared cloud cover information is available in map form within a few hours after the satellite has discharged its information. The utility customer can phone his query, get an explanation within one minute.

What has made this possible are *information-display systems* which translate data directly from computers into readily understandable form.

Shrinking to size:

Computer calculations can be made at speeds measured in billionths of a second. "Answers" can be turned out in millions of computer "words" every hour. But these miles of words must be reduced to manageable size before the "answer" makes any sense.

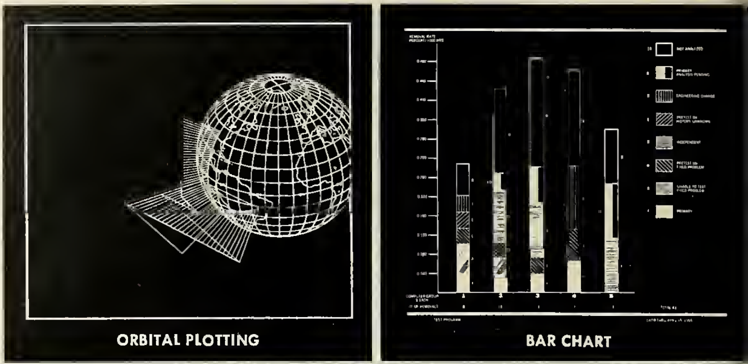
Now at the utility, the operator who receives a query simply punches the customer's account number into a keyboard connected to a central computer. Within one second, the customer's record appears on an information-display screen with a paper copy printed out if desired.

More complex equipment is helping hunt submarines, analyzing the radiation flux in the heart of a nuclear reactor, graphically showing the progress of a Gemini capsule in orbit.

The heart of the display systems produced by General Dynamics, through our Stromberg-Carlson subsidiary, is a specialized cathode ray tube.

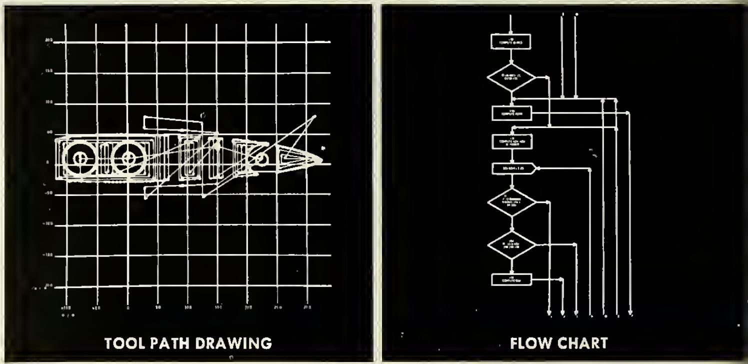
Data from a computer are converted to "steer" a stream of electrons through a matrix into which up to 200 different characters have been etched. The beam, focused on one at a time, is shaped as it passes through the matrix. When this shaped beam hits the phosphor-coated face of the tube, the character is reproduced—in some of our displays as fast as 100,000 characters per second.

Equally important is the ability of the system to "draw" on the face of the tube. Each "word" in a computer answer may represent the location of one data point or of a series of points. Short straight lines connecting these points may be drawn in any direction at rates averaging over 10,000 points per second, cumulatively building complex diagrams, even circles perfect to the eye. Drawings once laboriously hand-plotted over days or weeks now often can be completed within one second.



ORBITAL PLOTTING

BAR CHART



TOOL PATH DRAWING

FLOW CHART

PICTURES IN A SECOND, DRAWN BY COMPUTER-DISPLAY

Instant pictures:

The resulting words and pictures can be viewed directly, photographed on microfilm or printed out to provide immediate diagrams, tables, maps or charts. In fact, the computer-display systems have been used to make animated movies showing the probable behavior of a satellite in orbit and of shock waves in wind tunnel tests.

With company records in a central computer, the sales manager can get a detailed picture of the sales history of a product in any area, or the president, a financial summary—both in simple graphic form and within seconds after requesting the information.

Probably the most dramatic uses are "on-line, real-time" operations—showing what is actually happening at the moment. Consider one system being tested for local air traffic control.

A central computer receives up-to-the-second information on a plane's position, its flight plan, the weather and other conditions. Automatic devices in the plane transmit changes in position. Altitude, direction and speed are computed. The symbol representing the plane appears on the display screen. Next to it are letters and numbers indicating its flight number, altitude, speed and heading.

As the plane moves, its symbol moves across the display panel. As its speed and altitude change, so does the accompanying block of data on the screen. The controller can see at a glance exactly what planes are in his vicinity, their relation to each other and to his station. Possible trouble can be eliminated before it can start.

General Dynamics is a company of scientists, engineers and skilled workers whose interests cover every major field of technology, and who produce: aircraft; marine, space and missile systems; tactical support equipment; nuclear, electronic, and communication systems; machinery; building supplies; coal, gases.

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missiles and rockets

THE WEEKLY OF ADVANCED TECHNOLOGY

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THE COVER

Apollo/Saturn V 500F facilities vehicle being erected in high bay of the Vehicle Assembly Building at Merritt Island. The 500F vehicle plus an Apollo verification spacecraft will be used to check out the VAB, transportation of a full-scale vehicle on a mobile launcher, and the launch pad. See p. 15.

49,800 copies this issue

collage

A random collection of fact, opinion and miscellany... some of it a blatant attempt to peddle the products and capabilities of Motorola's Military Electronics Division.

Speak to me baby

bit by bit, digitally

A group of our engineers who can read and write are also involved in a project called Word Form Communications. They claim this concept can reduce the bandwidth required to send a given message by a factor of 3. This new encoding method maintains the system bit rate but time-compresses the digital data. How? By removing language redundancy and substituting coded word forms for most frequently used words. We've proven the feasibility of the idea with a black box ... filled with standard logic modules and a wired memory that holds over 125 of what our geniuses think are the most commonly used words. What they are is anyone's guess, but one must assume they are, for the most part, dull. If you write our Chicago Center they may or may not accept your suggestions for addition to the list, but might offer to show you the contraption. We suspect it's all a plot to transmit *so much* data *so fast* you'll just *have* to buy one of our high-speed teleprinters for readout.

While on the subject of words, would it be proper to say that someone who can't stand the works of Dr. S. I. Hayakawa is anti-semantic?

Continued on page 39

Letters

Lunar Dust First

To the Editor:

I would like to refer to the news item on our lunar dust contract with NASA in your Feb. 28 issue (p. 11).

In the March 21 Letters column, Mr. La Verne E. Woods of the Air Force Cambridge Research Laboratories claimed that our production of dust under vacuum was not a "first." (*Mr. Woods said in his letter that "here* [*at AFCRL*] *we have conducted such studies for the past three years, and in fact operated three vacuum chambers designed specifically for these studies capable of operating under pressures as low as* 10^{-11} *torr."—Ed.)*

Our scientific personnel are aware of the excellent work done in this area of technology by the personnel at AFCRL—particularly Dr. John W. Salisbury and his colleagues.

Our point is that our program involves the actual grinding of rock to dust-size particles under ultra-high-vacuum conditions. This, we feel, will closely simulate possible types of comminution on the lunar surface.

It is recognized that Dr. Salisbury and his group did a considerable amount of significant work with dust particles in vacuum, but from the available literature it appears that the comminution step took place under an inert gas atmosphere. We have kept up to date with all of their published work, and in no case do we find any mention of actually producing the dust in vacuum.

I am sure that the above represents our position in this case, and we do not feel that any retraction of our original statement is necessary.

Robert W. Love
Director of Marketing
and Contracts
Norton Exploratory Research
Division
National Research Corporation
Cambridge, Mass.

Ne Comprends Pas

To the Editor:

Though a very junior tech editor and an utter newcomer to the technical publications field, I cannot refrain from calling attention to your own misuse of what seems to be the most misused word in the field.

I refer to *comprise.* On page 32 of your May 2 issue you say "All of the labs *comprising* the facility . . ." It is a complete reversal of the meaning of comprise, and it is by far the most common use of a word that is overworked to begin with.

"Comprise . . . to include, esp. within a particular scope. To sum up," notes Webster. The dictionary adds that comprise comes from the French "compris," meaning including. Eric Partridge says "*comprise*, 'to constitute, to compose' is rare, and I think, to be avoided, as in 'ten dogs comprise the pack.'" He gives comprise as "to include, to sum up, to comprehend or include *under* or *in* a class or denomination . . . to contain, as in 'the house comprises box-room, nine bedrooms, bath-room, etc.'"

Best is Strunk and White in *The Elements of Style: "Comprise.* Literally, to *embrace.* A zoo comprises mammals, reptiles and birds. But animals do not comprise (embrace) a zoo—they *constitute* a zoo."

Forgive me if I seem pedantic, but English is bad enough for technical purposes without deliberately destroying what precision it is capable of achieving. And this word ranks as the leading offender in the hands of a careless technical writer. (Besides which it is so overworked and stale as to be almost a cliché.)

M/R should set higher standards.

Mack M. Braly
Techrep Division
Philco Corporation
Houston, Tex.

Webster (in both the Second and Third unabridged versions), after giving the definition quoted by Reader Braly, goes on to say: "To consist or be made up of; as, his family comprises five sons. . . . To make up or constitute; as, the chapters that comprise Part One." The last of these meanings is not described in the dictionary as archaic, colloquial or otherwise objectionable. Messrs. Partridge, Strunk and White are estimable authorities, but as a practical matter it is difficult to follow them consistently. M/R tries to use English properly, and in this case has not misused it.

—Ed.

Defaulting in Space

To the Editor:

I heartily concur in the sentiments expressed in your May 2 editorial ("No Second Best"). The United States certainly has what it takes to win any kind of space race, but stands in danger of painting itself into a corner.

W. L. Wilson
Chicago

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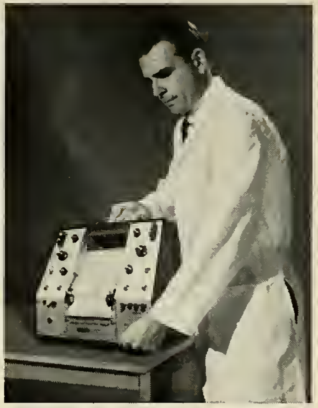

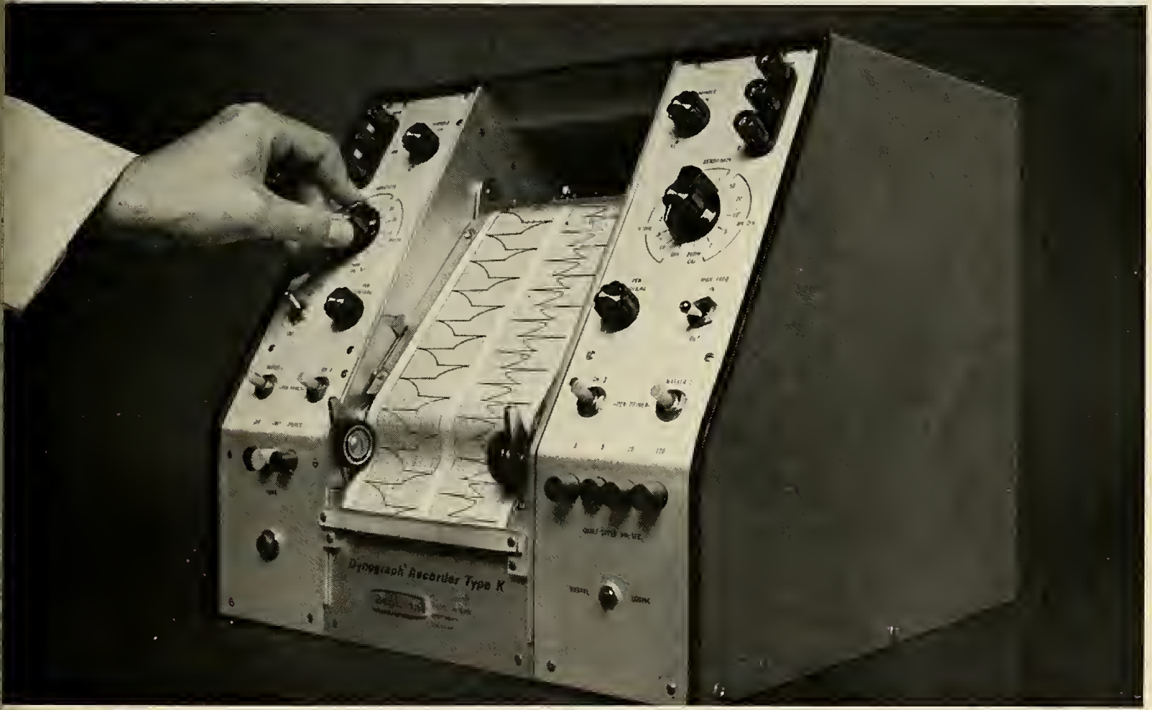

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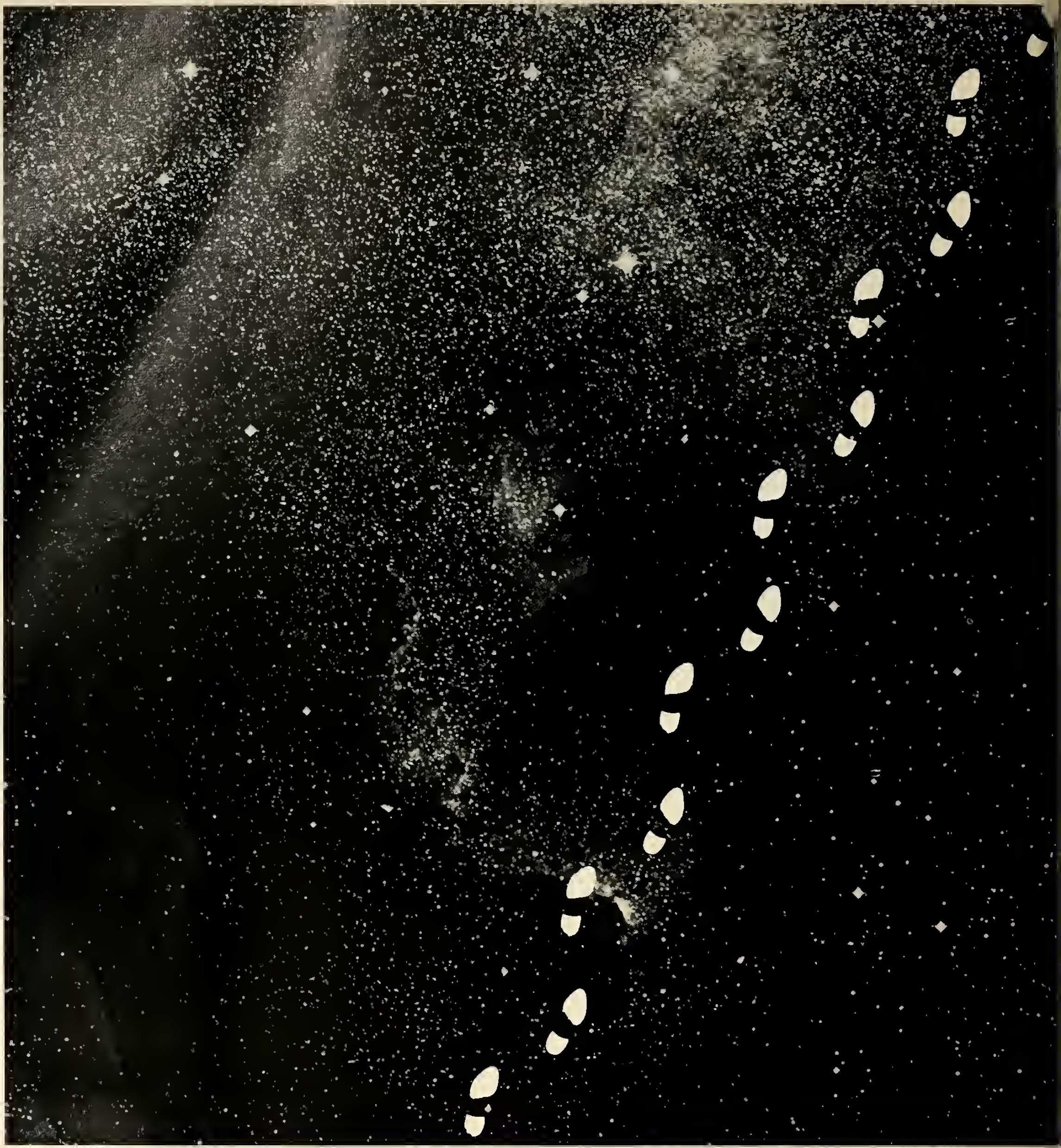

TRW Systems is an operating group of TRW Inc., a diversified manufacturer of automotive, electronics and aerospace systems and components.

Interplanetary space is our beat

The exploration of deep space began with our Pioneer I in 1958. Later we put Pioneer V into orbit for NASA and helped send Mariner II to Venus and Mariner IV to Mars. Our six Nuclear Detection Satellites are still monitoring outer space for the Air Force. And our two OGOs continue to gather scientific data for NASA. Not long ago we launched Pioneer VI into solar orbit. Now we're studying Voyager and manned Mars missions for NASA. We have built more kinds of spacecraft than any other manufacturer. And we have provided engineering services or hardware for 9 out of 10 U.S. space launches.

TRW SYSTEMS

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22-49-

The Countdown

WASHINGTON

RAM Propulsion Shoot-Out Set

Major contenders for the propulsion on Air Force's *hort-Range Attack Missile (SRAM)* will engage in a shoot-ut in August. A clear victory by any one of the firms—erojet, Thiokol or Lockheed Propulsion—will install that rm in the program regardless of whether Boeing or Martin nds the prime contract. Failure of all three to develop uccessful pulse-type motors may result in a review of ertain *SRAM* missions and use of more conventional ropulsion.

IASA Drops Supplemental Request

NASA has discarded any plans to ask Congress for sup-lemental funds in Fiscal 1967. Although there was some upport for this in the House Space Committee, the agency's p officials resisted pressure from the ranks for a $200-illion supplemental—primarily because of opposition of e Budget Bureau and other high-ranking Johnson Ad-inistration officials.

irst Mariner '69 Subsystem RFP Out

First request for proposals for a *Mariner* 1969 space-raft subsystem was issued May 10 by Jet Propulsion Lab-ratory. It covers mechanical and engineering work, which cludes building of the spacecraft structure, cabling and ermal control systems. RFP's for two other subsystems—ommand and control system and telecommunications sys-em—are to be issued before the end of this month.

Iavy Sights on SLBM Intercept . . .

Early Navy efforts to determine potential for a sea-ased system to intercept submarine-launched ballistic mis-iles (M/R, Apr. 4, p. 15; Dec. 13, p. 16) are believed to e focused on a boost-phase intercept, presumably using puts from a variety of data-collection systems.

. . And So Does the Air Force

Some industry observers anticipate a favorable Dept. of efense decision on the proposal for an air-launched bal-stic missile intercept system, intended to be particularly ffective against SLBM's from the growing Russian sub-arine threat.

IASA Activates Centrifuge for Apollo

Manned Spacecraft Center's newest multimillion-dollar acility, an *Apollo*-sized gondola on a 50-ft. centrifuge arm, ecame operational last week—a year behind schedule—hen a test subject in a *Gemini* couch was whirled at 4 rpm to experience 2½ g's. MSC hopes to train a team f operators in the next few months for manned tests on e centrifuge to qualify *Apollo* suits, equipment and in-trumentation for the first three-man mission later this year.

Iow You See Them, Now You Don't

Air Force Systems Commander Gen. Bernard Schriever, riefing an *ad hoc* committee last summer as it prepared look into Air Force relations with non-profit corpora-ons, told the group that the 65,000-man AFSC faced a ,000-man reduction in the 1965-70 time period. With the eport now complete, and containing a strong recommenda-on for continuing the services of these corporations (M/R, pril 25, p. 14), an AFSC spokesman tells COUNTDOWN at plans for a personnel reduction have been postponed.

New Sensors Help Bring Down Bombers

Movement toward operational status of new over-the-horizon radars and major improvements in satellite-based early warning sensors are believed to have played a key role in Secretary McNamara's decision to sharply reduce Strategic Air Command's airborne bomber alert force. Warning times from both systems virtually double that gleaned from BMEWS.

INDUSTRY

Standard Missile Program Ready to Move

Navy approval of a go-ahead on the *Standard* missile, replacement for *Tartar* and *Terrier,* will be followed later this month by a request to industry firms to indicate their interest in production of the weapon. General Dynamics, serving as designer and pilot production agency, is to present missile specifications to the Navy by mid-July—which means formal RFP's will not go out before late summer at the earliest. RFP's will cover both medium- and long-range versions of the missile, with separate companies expected to build the different motors required for the two. Except for the motor, both missiles are said to be identical.

FX Fighter Missile Requirement Seen

Design studies of the new FX tactical fighter aircraft by three firms—Boeing, Lockheed and North American Aviation—are to be completed by mid-July. Four-month study contracts totaling $815,000 were signed recently by Air Force's Aeronautical Systems Div. Each firm will develop several designs. FX may well be melded with Navy's VFAX proposal in the future to yield another multi-service, multi-mission aircraft (M/R, May 2, p. 7). Project is expected to generate new missile armament requirements, particularly for an Air Force air-to-air missile.

Aerojet to Begin M-1 Firings

Series of hot firings of the Aerojet-General M-1 liquid hydrogen engine will begin this month. The firings will continue through the summer. M-1 development has been canceled in a budget cutback but NASA is spending a small amount of money to fund the firings as part of its advanced technology effort.

INTERNATIONAL

France Holds Underwater Missile Tests

Mockups of the French *MSBS Polaris*-type missile were launched underwater from the French experimental submarine Gymnote during trials at sea in April. Start of construction of a home base for the French nuclear missile-launching subs on the Crozon Peninsula has been approved by authorities.

Japan To Finalize Nike-Hercules Plans

Japan is expected to give final approval to plans for production of *Nike-Hercules* surface-to-air missiles under U.S. license (M/R, March 14, p. 9) after its investigating mission returns late this month from a three-week U.S. tour. The five-man Defense Agency mission is talking with Dept. of Defense officials and missile contractors, including Douglas Aircraft, Western Electric and Hercules.

Technology Week

Gemini 9 Ready for Launch

Launch of the *Gemini 9* mission is still scheduled for May 17, with the first rendezvous with the *Agena* target vehicle slated for the third revolution of the Earth.

The three-day mission with Command Pilot Thomas P. Stafford and Pilot Eugene Cernan at the controls will also feature a two-hour-and-25-minute space walk. Cernan will begin his extravehicular activity near the end of the 13th revolution.

During the mission, the *Agena* will be inserted into a 185-statute-mi. circular orbit. The *Gemini 9* spacecraft will be placed in an initial 100-by-168-mi. orbit. Following the first rendezvous, which will take place about four hours after the *Gemini* launch, the spacecraft will dock with the *Agena.*

A test of the amount of bending the two vehicles undergo when they are joined and a redocking of the spacecraft will be made before the crew powers down the spacecraft for an eight-hour rest period.

DOD Clarifies Team Bidding

A new Defense policy statement on the continuity of industrial teams formed to bid on major defense projects is receiving considerable enthusiasm within the industry.

The statement, being distributed throughout the defense industry in a Defense Procurement Circular and soon to be incorporated in the Armed Services Procurement Regulations, has cleared the air in an area in which many industry executives felt there was no firm DOD policy.

In a joint memorandum distributed to service secretaries for research and development, and installations and logistics, DOD states that it will "recognize the integrity and validity of such team arrangements provided they are identified and company relationships are stated in a proposal." In any team proposal, they caution, the "prime contractor will still be fully responsible for the performance of the contract."

The DOD statement, issued jointly by Assistant Secretary of Defense Paul R. Ignatius (I&L) and DDR&E Director Dr. John S. Foster, Jr., says the objective of team arrangements should provide for complementing unique industrial capabilities to get optimum performance, cost, and schedule. "The formation of such teams," the officials declared, "shall be at the discretion of potential prime and subcontractors.

"The DOD normally will not require or encourage dissolution of such team arrangements," according to the statement.

The memorandum, however, also points out that this action does not limit DOD's right to: "approve proposed subcontracts in accordance with ASPR; direct the substitution of a specific team member for a substantive reason, such as unsatisfactory or marginal technical proposals; conduct so-called 'technical transfusion' using data rights belonging to the Government; and pursue its policies on competitive procurement, subcontracting and component breakout, after initial production procurement or at any other time that they are appropriate."

Major industry concern over what appeared to be confusion regarding DOD respect for team arrangements has been growing when such arrangements were broken into on programs such as the Air Force's *Manned Orbiting Laboratory, Short-Range Attack Missile (SRAM),* and C-5A aircraft projects.

The move to establish some guidelines in the team proposal area is principally the result of industry pressure.

AF Construction Money Asked

The Air Force is asking for $47.3 million in construction money to support research and development activities, including satellite control facilities, in-house laboratory support and facilities for the *Manned Orbiting Laboratory.*

According to Assistant Defense Secretary Paul R. Ignatius, in testimony before the House Armed Services Committee the *MOL* support facilities request is $8.7 million in the military construction authorization bill. Request for satellite control facilities is $12.4 million to increase the on-orbiting tracking and control network; $11 million is being asked for improvements at the Eastern and Western Test Ranges.

About $10.7 million is asked for in-house laboratory support, and $4.5 million for support facilities for R&D missions. The latter includes modification to facilities to support the advanced ballistic re-entry system at Vandenberg AFB, Calif., and satellite tracking alterations at Donnelly Flats Air Force Station, Alaska.

Army R&D-related construction requests include $31.3 million for *Nike-X* facilities at Kwajalein Island. Navy requests include $6.3 million for improvements at Patrick AFB, at the Naval Ordnance Test Center, Fla., to support development and testing of the *Poseidon* missile, and $1.4 million for the Atlantic Undersea Test Evaluation Cente (AUTEC), Andros Island, Bahamas.

Money requests for operations pr grams include $23.7 million for *Minut man* construction for improvements t achieve greater reliability, and $4. million for the Navy attack carri strike forces and anti-submarine wa fare forces ($6.2 million).

Total DOD request is for $1.04 billion.

Lockheed Stresses Oceanics

Elevation of its oceanographi activities to division status within th engineering branch has been announce by the Lockheed-California Co.

The new Oceanics Div. will shi from the Burbank, Calif.'s plant t Lockheed's Marine Laboratory at Sa Diego this month. William V. Kielhor head of the company's former ocea ography department, will manage th oceanics division.

Shots of the Week

The Soviet Union has launched tw more satellites in its *Cosmos* serie *Cosmos 117* was orbited on May followed by launch of *Cosmos 118* o May 11.

- A *Javelin* sounding rocket wa successfully launched from the Fo Churchill Research Range, Manitob Canada, on May 1 by the U.S. Ai Force Cambridge Research Laborator The rocket payload was designed t measure total and component magneti field values and primary electron an proton flexus during a magnetic-absorp tion event.

Apollo Program Gaining

A three-man *Apollo* flight may b possible during this calendar year, ac cording to Joseph Shea, NASA's *Apoll* program manager.

Speaking in Los Angeles on May 4 Shea said recent progress in *Saturn Apollo* hardware testing and development had shown a "gratifying" amoun of success.

Earliest *Apollo* plans called for three-man flight before Jan. 1, but constant revision of schedules has caused th date to be slipped to the first quarter o next year (M/R, March 7, p. 14). Shea' statement, in effect, said the progra had caught up with itself.

The NASA official also said that th Lunar Excursion Module (LEM) wil be flown by the middle of 1967 in program, ". . . continuing until we ar ure we can safely go to the Moon. . . .” Ie predicted there will be an ever-increasing schedule of LEM flights after nid-1967.

Later, other manned space flight fficials revealed that the first manned light of the *Saturn V* booster may come s early as *SA-503*. This, however, is ot really new. NASA's philosophy alls for two straight successes with a ehicle before it is man-rated. Thus, the hird *Saturn V* booster will be man-ated if the first two unmanned missions re successful. With two successful nanned missions, the agency will probbly be ready to attempt the manned unar landing, perhaps as early as mid-968 (M/R, Nov. 1, p. 15).

urveyor Engines Tested

A successful test of *Surveyor's* three quid engines which will be used for the nal approach to the lunar surface was arried out May 10 at Holloman AFB, .M., by NASA's Jet Propulsion Labratory and prime contractor Hughes ircraft Co.

The spacecraft engines were turned n while the craft traveled at 45 mph t an altitude of 625 ft. The engines educed the speed to an acceptable 3.5 nph for a soft landing.

Chinese Bomb Data Studied

U.S. nuclear experts were expected o have air sampling data late last week o provide details on the most recent Chinese nuclear explosion, which took lace on May 9.

Initial measurement of fallout by apanese scientists indicated radioctivity levels at least 33% higher than ad been anticipated. Also, the rapidity vith which the nuclear debris reached he Japanese mainland indicates exploion of a device considerably larger than e originally estimated 20 kilotons. It nay also suggest that the device was ropped from an aircraft rather than xploded on a tower.

Metal particles in the air sampling sually reveal whether or not a launch ower was vaporized. The height of the uclear cloud also provides a clue to he launch mechanism used.

While the official Chinese statement ndicated that thermonuclear material vas included in the most recent test, will not be clear until the sampled ata is evaluated whether or not the Chinese are moving toward development f the trigger device needed for a thernonuclear bomb, or are seeking to deelop an especially "dirty" form of omb that employs fusion to break an uter casing of uranium 238.

Most experts believe the Chinese are iming at the thermonuclear weapon, nd that their progress has been rapid.

Several thousand scientists and engineers will see this message, but . . .

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Joint NASA/DOD Tracking Net Studied

by Hal Taylor

WASHINGTON, D.C.—NASA and the Defense Dept. are considering a possible joint satellite tracking network which could replace current ground and ship facilities in the early 1970's.

The space agency recently took the first major step leading to the system with selection of Lockheed Aircraft Corp. and Radio Corp. of America for negotiations for a feasibility study of an Orbiting Data Relay Network (ODRN).

DOD has already funded two similar studies of a satellite system which would have tracking, data acquisition and command functions.

The possibility of a joint satellite tracking system in the future was revealed in letters from the Defense Dept. and NASA to Rep. Chet Holifield (D-Calif.) of the Military Operations Subcommittee of the House Government Operations Committee.

DOD optimistic—Dr. John S. Foster, director of defense research and engineering, told the committee that DOD sees many potential advantages, perhaps in the early- or mid-1970's, for such a system.

"Two feasibility studies have been made by the Electronics Systems Div., Air Force Systems Command. The final reports were issued about six months ago, with copies provided to many agencies, including NASA," he said.

"It is too early to judge positively the operational and cost advantages of such a satellite system; however, we believe that the potential advantages would be greater if a future system could serve both DOD and NASA as the result of an early standardization effort," Foster said. The space flight ground environmental panel of the DOD/NASA Aeronautics and Astronautics Coordinating Board is giving special attention to maintaining close NASA/DOD coordination on this subject, he concluded.

NASA's viewpoint—A similar view was also expressed by the space agency. Deputy Administrator Robert C. Seamans, Jr., said that the DOD study of an instrumented satellite for obtaining metric tracking data and the NASA study of an orbiting data relay satellite are being monitored by the AACB.

"Although the studies of both systems are still in the early conceptual phase, there has already been a full exchange of information between NASA and DOD on the matter. This coordination will continue and in the event that development is undertaken, we expect to work with DOD to achieve a common system," he told the committee.

Lockheed and RCA were selected for final negotiations for the study of the ODRN late last week. It could not be learned whether the firms will make parallel studies of the systems or whether only one of the firms will be selected for a study.

The feasibility study phase of ODRN will last six months. Six other firms—Booz-Allen Applied Research, Inc., General Electric Co., Hughes Aircraft Co., Hydrospace Systems, System Sciences Corp., and TRW Inc.—also submitted bids Feb. 9 for the system study contract. The contract is expected to be worth about $100,000.

Configuration—The ODRN would consist of two or more satellites in synchronous orbits 22,300 miles over the equator. Each satellite would carry the equivalent of a 30-ft. antenna, probably the multiple-beam, phased-array type. This would allow it to receive simultaneously from several spacecraft.

Primary objective of the network would be to enhance two-way voice and data communications between the spacecraft and mission control centers.

These transmissions now must go through ground relay stations, many of them in foreign countries, before being transmitted to the U.S.

NASA, along with DOD, is also studying the possibilities of actual spacecraft tracking via the satellites, perhaps by having the satellite send a ground-originated tracking signal to a spacecraft which would return it through the satellite to the ground. The length of the transmission would reveal the range of the spacecraft. Another concept calls for the tracking to be done by equipment on board the spacecraft with no ground stations involved.

One of the space agency's objects in establishing the new satellite system would be to replace its secondary voice and telemetry stations such as those at Kano, Nigeria, or Canton Island in the Pacific. These stations do not transmit directly to the mission control centers.

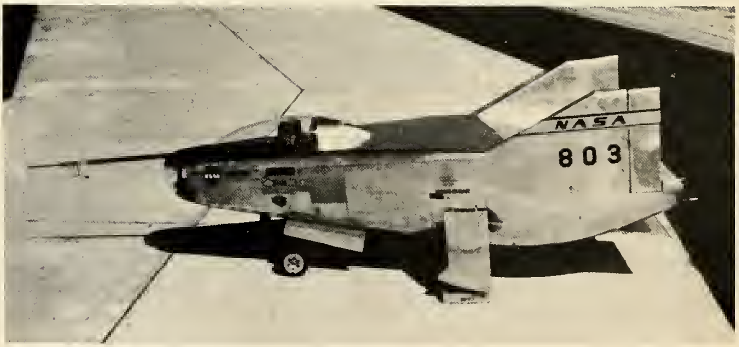
The study contractor for ODRN will have to determine the number and location of the relay satellites and any ground stations required to maximize the operational capability of the system.

Space agency officials believe that tracking will remain on the ground and that some overseas and domestic stations will be retained. It is also reasonably certain that several stations beside the secondary ones would be shut down if the orbiting network is approved.

As their equipment becomes obsolete in the 1970's, these stations will be abandoned.

The network would also probably eliminate the eight instrumented C-135 aircraft which are used to relay voice communications on *Apollo* missions.

The Air Force seems to feel, however, that a joint tracking, data acquisition and command satellite system would greatly reduce the need for ground stations. ∎



M2-F2 Lifting Body Shown

NASA's M2-F2 lifting body is scheduled for its first air-launch from a B-52 aircraft within the next few weeks. The heavyweight re-entry vehicle will be launched from an altitude of 45,000 ft. at a speed of about 500 mph. It is being used to study the concept for possible use in a piloted spacecraft.

Space Council, House Panel Press for Post-Lunar Plans

WASHINGTON—The National Aeronautics and Space Council and the House Space Committee are taking actions to force a decision on U.S. space plans after the lunar landing.

Mindful that the Fiscal Year 1968 budget represents the critical year for NASA's future programs, the two bodies have been acting separately in hopes of eliciting a strong stand by the Administration on future goals.

The Space Council met April 29 in a session devoted to presentations by NASA, the Department of Defense and the Atomic Energy Commission on their projections of the future. It will hold additional meetings from which it hopes to prepare a recommendation for the President.

The House Space Committee's NASA Oversight Subcommittee has asked for opinions on the subject from every conceivably interested source, Rep Olin Teague (D-Tex.) told MISSILES AND ROCKETS. This includes every committee, agency center and company in the space program.

The document is expected to be published in book form by the committee in about six weeks, making it available for consideration during preparation of the FY '68 budget.

MOL/AAP cooperation — Meanwhile, in letters to the House Military Operations Subcommittee, top officials of DOD and NASA adroitly avoided direct reference to committee suggestions that NASA's *Apollo* Applications Program be merged into the Air Force's *Manned Orbiting Laboratory* program.

However, Dr. John S. Foster, Defense Director of Research and Engineering, told the committee that a working group has been set up by the Manned Space Flight Policy Committee to examine specific interface areas between the *MOL* and AAP programs.

Thus far, two distinct areas of need have been identified in the application of existing NASA support equipment to the *MOL* program, Foster said. These are the support of the early Heat Shield Qualification flight tests scheduled at the Eastern Test Range late this year, and longer-term requirements for *MOL* operations at the Western Test Range.

Over two hundred distinct major end-items have been identified in negotiations for Heat Shield Qualification support equipment, Foster said. These include a telemetering ground station, consoles for launch control trailers, pressurant and propellant servicing carts, pressure and electrical checkout equipment, handling carts and pyrotechnic servicing equipment.

He added that the program is proceeding satisfactorily, with "high confidence that availability of NASA support equipment to the *MOL* program will conform to the launch schedule."

Approximately 3,350 *Gemini* support equipment items have been surveyed, and only nine conflicts in use have occurred, Foster also disclosed. Should new procurements be necessary to solve these conflicts, costs will be less than $500,000.

Negotiations for the transfer of *Gemini* support equipment to Air Force accountability are nearly complete, Foster said.

Bottleneck—Foster indicated that the Air Force will not be able to use NASA simulation chambers at Houston because these are completely committed to the *Apollo* program through 1970.

NASA has, in fact, had to approach the Air Force Arnold Engineering Development Center for thermal balance testing of the Lunar Excursion Module and Instrument Unit of the *Apollo* Applications Program, beginning in 1968, he disclosed.

The letter said that the Douglas facilities at Huntington Beach, Calif., will be expanded to accommodate the *MOL* "at little or no cost to the Government." Some question was raised by the committee on this point.

Foster listed other activities being considered by DOD and NASA which will lead to further cooperation. Among these are the establishment of an *ad hoc* study group to examine NASA/DOD supply consolidation at WTR, and the drafting of a new cost-sharing and reimbursement arrangement at ETR.

DOD is further tightening up its own range and launch activities, he said, by the staffing of an agreement defining operational responsibilities during each cycle of an orbital mission between the satellite Control Facility and the National Range Division. The Navy's program also is receiving attention, through the consolidation of Navy RDT&E range and tracking activities under the Chief of Naval Operations.

In a return letter to Foster, Rep. Chet Holifield (D-Calif.), chairman of the subcommittee, again expressed his conviction that the two manned spaceflight programs could be merged.

"I sincerely believe that the near future experimental objectives of both DOD and NASA in the manned orbital field can be realized through the *MOL* without having two separate multibillion-dollar programs. Therefore, I urge you to do all you can to insure that the Policy Committee, by vigorous and open-minded discussion, arrives at a truly unified effort."

Budget action—The Senate Space Committee will report out its version of the NASA authorization bill this week. After action by the Senate, differences between the bill and the $4.981-billion House version must be ironed out in conference.

The House completed its actions on the NASA budget last week by clearing the Independent Offices Appropriation bill, which must follow the authorization bill before the money is cleared for spending. The House version of the appropriation would bring the level to $4.950 billion.

Both the House and Senate last week passed the Atomic Energy Commission's authorization bill, granting full requests for space and rocket propulsion research. ■

Mohole Cut Attacked

HOUSE MEMBERS fighting for the National Science Foundation's Project Mohole are hoping that the Senate will restore funds for it in the Independent Office Appropriations bill.

Protesting the House Appropriations Committee's deletion of the Administration request for $19.7 million for Mohole, a number of House members, including Chairman George P. Miller (D-Calif.) of the House Space Committee, said Mohole and oceanography in general suffer because programs are divided among seven Government departments.

Had Mohole been in the Space Committee, Miller said, the committee would have come in "fighting for it." However, with no legislative committee directly responsible, oceanography is an orphan science, he indicated.

Rep. Joe Evins (D.-Tenn.), chairman of the Independent Offices subcommittee which voted down the funds, said the overall cost of Mohole was originally projected at from $46 to $47 million, but went to $65 million and then to a half billion. The subcommittee felt that oceanographic sediment-drilling was "overly funded," and cut the project to save money.

DOD Moves To Sharpen Air Combat

by Michael Getler

WASHINGTON—The Defense Department has embarked on a new program to increase the number of live air-to-air missile firings made by flight crews in training to determine if it adds to air crew efficiency when locked in actual air combat.

Although some live firings are made during training, DOD policy up until very recently has called for only a very limited number of these in comparison to the number of training flights made, in which all actions except actual missile release are carried out.

Principal reason for the limited number of actual missile launchings thus far has been the high cost of missiles and target drones used in this phase of training.

Defense officials say that "it is hard to prove that you need to fire more birds in training," but that "a program is under way to see if there is any gain in efficiency." The program could run for at least six months, and possibly longer.

While Government officials have publicly tried to play down any concern over U.S. air-to-air missile problems to date in Vietnam, there is, nevertheless, considerable activity in DOD and the services to improve performance. DOD officials correctly point out that though some problems have been encountered, this can be expected in any first actual combat test of weapons systems, such as the *Sparrow III* missile. They also note that no large body of data is available yet from which to draw firm conclusions, and that U.S. aircraft "most certainly have won all the exchanges thus far."

Drawing blood—Most recently, U.S. *Sidewinder* missiles have brought down a Mig-17 and Mig-21 aircraft (M/R, May 2, p. 8) and a *Sparrow III* is credited with a Mig-17 kill. *Sidewinder* is also credited with two Mig-17's in earlier engagements. No U.S. aircraft have been reported lost to date to enemy air-to-air missile fire, although Migs have fired heat-seeking missiles at Air Force and Navy F4B and C aircraft.

During these recent air battles, however, several attempted missile firings by U.S. crews resulted either in failure of the missile to leave the aircraft or a miss of the target. An Air Force/industry team left for Vietnam this month to review maintenance procedures.

In private, defense officials admit that there is much room for improvement.

Better drones needed—In addition to the decision to increase the number of live missile training firings, DOD is also embarked on a project to improve the capabilities of U.S. target drones to more realistically simulate combat conditions, and has created a new office within the Directorate of Defense Research & Engineering to deal directly with DDR&E's test and evaluation function.

Service activity extends from improved training and tactics procedures to modifications of existing drones. A major service/industry effort is also under way to improve reliability of these systems in the rough handling environment of Southeast Asia operations and to review overall field maintenance and calibration techniques.

Defense officials report that there is nothing now in the U.S. drone inventory that can pull even 5 g's. Planners say an ability to handle g-loadings greater than 5 would greatly increase the ability to program drones to maneuver and better simulate dogfights.

A recommendation is expected to evolve from DDR&E in the not-too-distant future for a greatly improved drone that would have this capability, in addition to a higher speed and altitude performance.

The drone effort is centered on improving the existing and extensively used vehicles such as the Ryan BQM-34A, which is now being upgraded to supersonic capability. Other drones used for missile training include the Beech-built supersonic AQM-37A, and unmanned versions of F9F and F-104 aircraft.

Defense officials told MISSILES AND ROCKETS that most service activity is in the Navy and Army and that lack of Air Force acvtivity in this field has tended to weaken the effort (M/R, March 28, p. 56).

Navy and Army designers are also attempting to come up with improved drone formation control systems in an effort to develop tactics which would avoid confusing missile guidance systems during multiple target attacks.

New DDR&E office—It has been apparent for some time, defense officials explain, that DDR&E was focused overwhelmingly upon the R&D portions of its assignment to the neglect of its responsibilities in test and evaluation. Officials say the organization was not getting the proper feedback on flight and field test of systems once they left the basic R&D stages, and that this was affecting complete analysis of R&D effectiveness.

Result has been the establishment late in March, of a new office, the Assistant Director for Operational Tes and Evaluation, to oversee all T&E operations. Rear Adm. Vincent P. dePoi has been named to head the office. H reports to Lt. Gen. William J. Ely DDR&E Deputy Director for Administration and Management. The office however, will, to a large extent, b working directly with the functional lin offices of DDR&E.

The new office will have some strategic work, but the bulk of its schedul is heavily weighted to problems of tactical warfare.

Strategically, the new group will b viewing the results of major Strategi Air Command-Air Defense Comman joint training exercises to determin R&D implications.

In the tactical field, the office wil be concerned with results of new programs such as that initiated in the increased missile firing project. Officials stress, however, that the office will no impinge upon service responsibilities for actually carrying out training.

Scope of function—The office wil look into service T&E plans for major new weapons systems to make sure they meet specifications and operationa needs and will also review results of the T&E phases. Also, the office will investigate results of R&D fixes on equipment already in use.

In addition, investigations of facilities for joint service conduct of T&E will be carried out. Work carried on at the Air Force's inertial guidance complex at Holloman AFB, N.M., for example, will be more closely analyzed to derive maximum service-wide benefit.

The office has also become the new focal point for DOD's Joint Task Force-2 operations. The JTF-2 group is currently charged with a T&E assignment in the low-altitude flight regime, attempting to lay out optimum low-altitude aircraft/missile penetration techniques and defense avoidance, while at the same time studying the optimum defense against clever penetration schemes. The project is a far-reaching one, extending into new aircraft and missile systems beyond those now in service.

Programming and budgeting control for DOD-funded T&E systems is also extended to the new office. New systems coming under this include the Air Force's Weapons Effectiveness Testing System (AFWETS) and all Army test systems falling under the Army Test Program Element. ■

MILA Launch Site Readied For First Saturn V Vehicle

CAPE KENNEDY, FLA.—Pad A of NASA's Merritt Island Launch Area complex 39 will be checked out and ready for the first multimillion-pound-thrust *Saturn V* booster in August.

Thus, the pad and the Vehicle Assembly Bulding (VAB) will be ready for erection of the stages of the giant booster scheduled to arrive at Cape Kennedy in late August or September.

This could permit a launch of the *Saturn V* late this year if checkout of the launch vehicle proceeds without any technical problems. NASA's unofficial schedule calls for a launch in December, but the space agency has it officially scheduled for the first quarter of 1967.

December shot unlikely—There are not many NASA officials who are optimistic about meeting the December date. They believe that enough technical problems will crop up during the long checkout of the vehicle to push the first flight into next year.

In addition to the VAB and launch pad A, the *Saturn* facilities consist of launch pad B, two crawler vehicles and three launch umbilical towers (LUT).

Construction and checkout of launch pad B is slated for the summer of 1967. This will give the space agency a two-launch-pad capability for the *Apollo* manned lunar landing program that could permit a speedup in launches.

At this time, the *Saturn V* 500 F facilities vehicle is being used to check out the VAB and launch pad A. All three stages of the 500 F and the *Apollo* been erected and mated inside one bay verification vehicle spacecraft have now of the VAB. They will later be moved by the crawler with LUT 1 to launch pad A for final checkout of the equipment that will be used to launch the first *Saturn V*.

Facilities status detailed—The status of other *Saturn V/Apollo* launch facilities follows:

Crawler No. 1 is already classed as operational for use with the LUT. June 1 has been set for completion date on crawler No. 2, on which final assembly is now in progress. It will be operational in August.

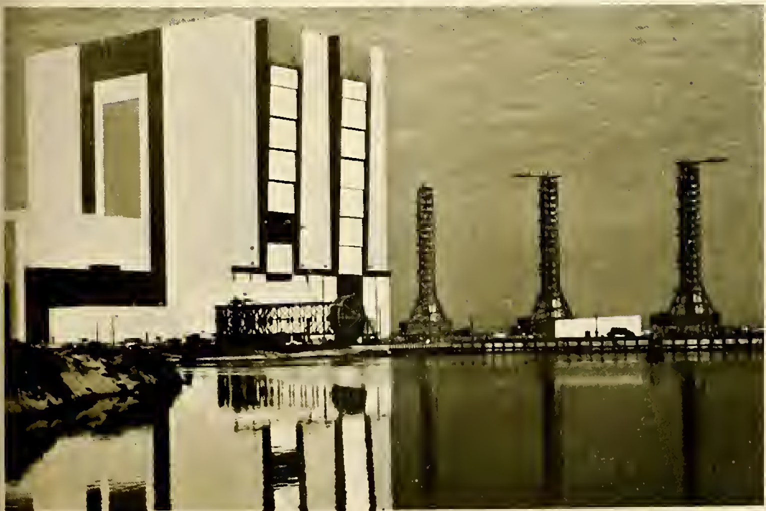
The *Saturn-Apollo* LUT No. 1 is currently in an activation phase, and nearing completion. It will transport the *Apollo-Saturn* 500F to pad A on May 25, and it will be completely operational in September.

Ground-support equipment is being installed in LUT No. 2. It will be finished by December. A January completion date has been set for LUT No. 3.

Activation on launch pad A has been scheduled for completion by May 25, in time for the 500F rollout. Construction is under way on pad B, which will be finished by mid-August of this year, and operational by March, 1967.

Elevation of Apollo verification vehicle spacecraft onto 500F facility vehicle takes place at Kennedy Space Center's Vehicle Assembly Building as part of VAB and launch pad checkout procedure.

At launch complex 39, Appolo-Saturn vehicles will be assembled on launch umbilical towers (LUT), right, inside the 52-story Vehicle Assembly Building. After assembly, each complete Appolo/Saturn system will be transferred to the launch area over a roadway designed to support loads of approximately 18,000,000 lbs. One of two crawler vehicles will lift and carry the LUT and Apollo/Saturn V combinations.



The mobile service structure—one of a kind—is now under construction, with completion slated for mid-August. It is expected to be operational in early December.

Only half of the VAB is currently being made operational. At present, two low bays for the S-IVB stages and two low bays for S-II stages are completed and operational. Their activation coincides with two high-bay areas being put into use. Another four low-bay areas are being used for storage.

Construction is complete and high-bay area No. 1 is now being activated. It will be ready in time for the first *Saturn-Apollo* flight late this year. High-bay areas 2 and 4 are not being activated at present. But construction is complete on high bay No. 3 and the activation phase is in progress, aiming for a Dec. 1 completion date.

In the launch control center, firing rooms 1 and 2 are being worked on in support of VAB high bays 1 and 3. Firing room 1 is undergoing activation and integrated testing of ground and electrical support equipment, complete enough to support a 500F test.

Firing room No. 2 is now being activated, and is on schedule for a Dec. 1 completion date.

Firing rooms 3 and 4 at present are being utilized for storage and office space. ■

Tape Memory Unit Awaits GT-9 Test

by Charles D. LaFond

OWEGO, N.Y.—Use of an auxiliary tape memory (ATM) unit in the *Gemini 9* mission scheduled this week will provide the second operational flight test to further validate the subsystem's concept.

Despite marked success in its first use in the *Gemini 8* mission last March, the ATM unit, which greatly expanded the on-board guidance system's computer storage and system reliability, received little notice. Yet many believe that initial use of magnetic tape in space as a bulk computer storage method will lead to its ever-increasing adoption in aerospace-guidance flight systems.

Conceived by IBM's Federal Systems Div. here and developed by Raymond Engineering Laboratory, Inc., Middletown, Conn., the ATM provides a means for expanding the IBM-built *Gemini* digital computer by a factor of seven (90,000 13-bit words), and eliminates the previous need for reprogramming the instrument by radio from NASA ground stations.

Astronauts are thus given the capability to insert at will from the ATM any of the three currently required programs employed throughout a complete *Gemini* flight: central control; touchdown prediction and re-entry; ascent, catch-up and rendezvous.

The 59-lb. *Gemini* computers, used in six previous missions totaling nearly 70 operating hours, have proved to be invaluable assistants to the astronauts in carrying out their complex schedules in orbit. The addition of the ATM reduces their dependence on NASA's global ground network and provides an inherent increase in guidance-system confidence.

Additional programs now in development are expected to be included in future missions to further extend crew capability. For example, a new program module is planned for *Gemini 10* which will permit pilot insertion of sextant readings for use in an on-board orbital navigation experiment.

Developmental history—Pressed by an evidently steady increase in requirements for the *Gemini* computer as mission complexity grew, IBM began work on approaches to expand the storage capacity of the digital system. By June, 1964, working with NASA engineers, the hardware concept was firmed up by IBM for use of a high-density-tape bulk memory unit.

Breadboard integration with the entire *Gemini* inertial guidance system was completed here by February, 1965, and IBM was awarded a production contract of about $1.5 million by McDonnell Aircraft Corp., *Gemini* prime contractor, last July. The contract called for development of one prototype and six production models of the ATM, plus software.

Raymond was given a subcontract by IBM in July for $1 million and its prototype was delivered to IBM early in the fall. The first flight model, destined for *Gemini 8,* was delivered to McDonnell eight weeks later. The last ATM will be delivered by Raymond to IBM late this month.

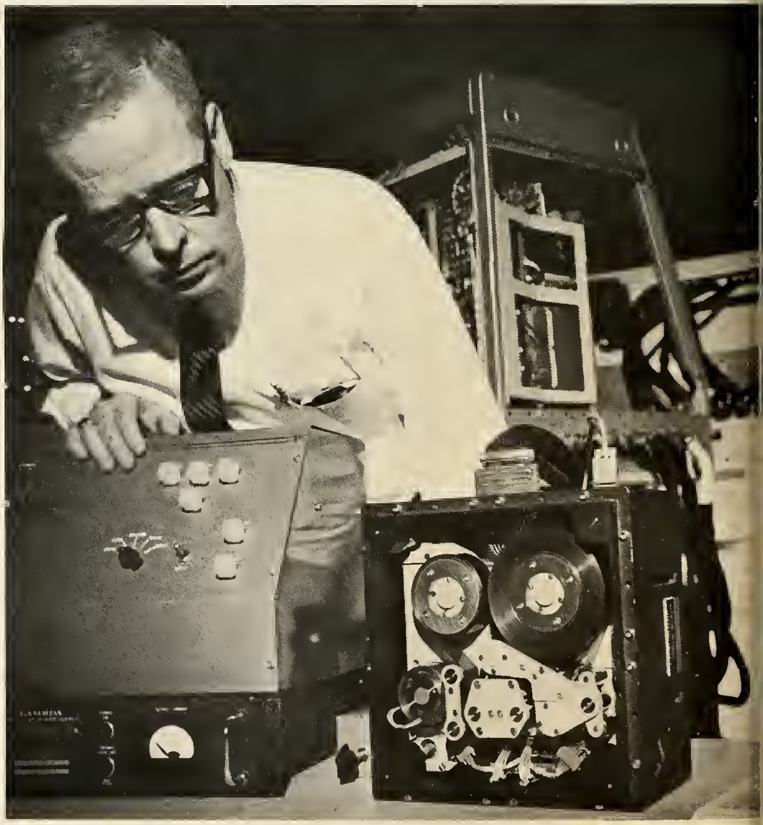
Subsystem details—The 26-lb. ATM measures 10 x 10 x 7 in. and provides 525 ft. of 1-in., 16-channel, high-revolution magnetic tape. Total capacity is 12.5 x 10^6 bits (using 15 channels) with a storage density of 133 bits per inch per channel. Power need is 18 watts.

Hermetically sealed, the unit is pressurized at 20 psi with a dry nitrogen, helium, and Freon-12 mixture to suppress static electrical charge buildup.

Each of the *Gemini* mission programs is recorded sequentially and the data for each are recorded in parallel three times on 15 of the 16 data channels (9 data, 3 parity, 3 clock, 1 spare). Through the use of majority voting, the existing tape error rate of 1 in 10^5 was reduced to 1 in 10^{10}, according to IBM estimates. To further improve reliability and reduce data locating speed on the magnetic tape, the triple-redundant data are recorded in total two times. Thus, when called up by the astronaut for insertion in the computer, the nearest available program module on the tape is employed.

With such an approach, largely

IBM engineer checks Gemini auxiliary tape memory as it transfers a flight program into spacecraft's on-board computer during a laboratory test. The unit weighs 26 lbs.



eliminating the danger of data drop-out, the unit reliability is estimated at 0.998 for 3.3 hours actual operating time (or greater than any presently contemplated *Gemini* flight requirement).

To reprogram, verify, or do both operations, the astronaut keys the proper code and switches on the manual data insertion unit in the spacecraft. The computer then searches the tape for the proper program, and data transfer begins. Reprogramming requires 6 min.; verification another 6. Data are transferred into the computer memory at 36,000 bits per minute. Thus ATM is a slow-access storage unit.

In addition to the majority voting check of data within the tape-transport electronic logic, the computer itself, after receiving each data word and parity bit, determines the correct parity bit from the data word and compares it with the bit received from the ATM. If disagreement results, the computer malfunction light goes on.

In a typical transfer of 26 data bits, the information is automatically checked 16 times.

Future significance—IBM officials pointed out that the great growth in the tape industry has paralleled the commercial/industrial computer market with which it has been so closely associated as an auxiliary memory tool. Despite this broad use, tape memories have been noticeably absent from non-commercial computer systems, and particularly from flight hardware.

GT-4 emphasized this problem (June, 1965) when the computer failed during the 48th revolution. No memory was available to reload the system's main memory, which had been inadvertently dumped. At the time of its design, the *Gemini* computer was provided only with a drum memory, considered quite sufficient for the needs then. Also, tape units did not provide the high reliability demanded by space needs and a tape system was not employed as backup.

Tape transports and associated electronics and logic techniques have been steadily improved since the early '60's. However, present use of tape units as memories in non-commercial equipment is somewhat analogous to commercial-system use of 1953-54.

A re-start capability with a large memory size, IBM officials predict, is a necessity for future manned space systems. They also forecast an equal growth of both drum and tape memory units in expanding storage capacities.

There is also a move toward increased use of general-purpose computers for manned space use. For such systems, IBM officials assert, both tape and drum memories offer a potentially lower cost per stored bit than other applicable memory devices. ■

Soviet Spacecraft Sterilization Methods Aired at COSPAR

by William S. Beller

VIENNA—Soviet scientists have disclosed for the first time details of their methods and theories for sterilizing spacecraft.

The revelations were so unexpected that during the discussions following the disclosures, several Western scientists rose to congratulate the Russians for this free exchange of data at the COSPAR (Committee on Space Research) meetings here May 10-19.

In another display of candor, the Soviets in their national report indicated eagerness to move into the communications satellite business to a major degree. The intensity of this interest was reflected in the stress the Russian report placed on the practical aspects of communications satellites and the country's five-year plan to develop them further.

Red Comsats—Russia has launched three *Molniya* satellites—*Molniya-1A* in April, 1965, *Molniya-1B* last Oct. 14, and *Molniya-1C* on April 25. All are in orbit and accumulating experimental data for constructing a commercial communications system, says the report.

It is well known that the USSR recently established telephone and telegraph service with France via the *Molniya* satellites. But the Russians are looking further into the commercial market, according to the report, which notes that the present *Molniya* satellites even now can be used for transmission of television programs between countries of the Northern Hemisphere, including Southeast Asia and North America.

Russia has a five-year plan in which the use of satellites for communication purposes will be extended. Part of this plan includes work on a system for direct broadcasts from satellites to conventional commercial television sets.

Spacecraft sterilization — Sterilization methods used by the Soviet are analogous to those used in the United States, Dr. Lawrence B. Hall, NASA scientist specializing in planetary-quarantine, told MISSILES AND ROCKETS.

Soviet scientist A. G. Prishchep, in a joint paper with colleague V. I. Vashkov, noted three methods used to sterilize spacecraft—physical, chemical and mechanical. Hot air and ionizing radiation are used in Russian work, particularly ultraviolet radiations in the manufacturing process.

Prishchep said that chemical agents are used in the form of solutions—for instance, betapropiolactone, hydrogen peroxide, or agents in a gaseous state. Among gaseous agents, the mixtures of ethylene oxide with carbon dioxide, freons and others have been widely used, he said.

The explosion-proof mixture of ethylene oxide and methyl bromide received great attention in Prishchep's talk and in a subsequent paper by Soviet scientist E. N. Nikiforova. In fact, this mixture was part of the technique used to sterilize *Venus II* and *Venus III*, Nikiforova said in answer to a question from the floor. The gas mixture was used with a relative humidity from 30 to 90% because the mixture works best with humidity. She added that the proportions were 60% ethylene oxide and 40% methyl bromide, by volume.

Earlier, the spacecraft had undergone dry-heat sterilization, with the temperature somewhere between 160 and 200°C. If the temperature is less than 160°C the time is sharply increased for sterilization, Nikiforova said.

When the mixture of ethylene oxide and methyl bromide is used at a rate of 1.6 grams per liter at 40°C and 30-90% relative humidity, sterility is achieved in 2-48 hours depending on the material of the object sterilized—for instance silk or thick felt—according to the report.

Because the mixture has such a high penetrating power, quoted as having a sterilizing effect up to 10 mm into the thickness of rubber, experimenters can use paper and polyethylene to pack objects to be sterilized, Prishchep said. He noted that under the same circumstances, the mixture exceeds carboxide in antiseptic properties by a factor of four.

"Treatments with the mixture do not alter mechanical properties of plastics or rubber," he said, "nor do they influence the work of radio sets or electric appliances, which allow us to recommend it" for spacecraft sterilization.

Materials sterilized by means of this gaseous mixture do not acquire toxicity. This has been proved experimentally by putting sterilized specimens under the skins of live rats and dogs, said Prishchep.

The Soviet speakers emphasized that no single sterilization method will work for a spacecraft but that a combination of methods must be used. The sterilization of some materials and articles, such as rubber, lubricants, and electronic equipment, can be achieved by exposure to gamma rays at a rate of 2.5 million rad. Liquids used in Soviet spacecraft are sterilized by filtering them through asbestos filters similar to those employed in the medical industry. "The final stage of sterilizing the surfaces of a spacecraft is its sterilization effected by the gas method," said Nikiforova.

Lax standards—J. O. Light, Jet Propulsion Laboratory scientist, sharply criticized the COSPAR spacecraft sterilization standards as incomplete. He said they should be modified to form a more general and more effective planetary quarantine policy.

As an example, he suggested considering the *Voyager* missions planned for Mars for the 1970's. Each vehicle launched toward the planet will consist of a heat-sterilized landing capsule coupled through a biological barrier to an unsterile vehicle designed to orbit around Mars.

Present standards take care of the circumstances of incomplete sterilization or an accidental impact of the unsterile vehicle.

But there are many other ways to contaminate Mars not covered by present COSPAR standards, according to Light. The various effluxes from the unsterile spacecraft, such as propulsion system outgassing or spalling from micrometeoroid impact, might impinge on the planet.

He suggests the possibility of a micrometeoroid puncturing the biological barrier surrounding the sterile landing capsule, followed by some efflux from the unsterile craft depositing itself in the open area.

To take care of this circumstance, Light suggests that the planetary quarantine policy require 99.9% confidence that the unmanned exploration of Mars will not contaminate the planet with terrestrial organisms.

The Soviet gave out some preliminary data on the two dogs carried aboard *Cosmos 110* for 22 days this past February and March. The experiment was performed to examine the neuroreflex regulation of the cardiovascular system, peculiarities of water-salt exchange, functioning of the alimentary canal, and state of the musculo-skeletal system under orbital conditions.

Judging from telemetry signals from the dogs and postflight examinations, "the state of the animals during flight and after landing was satisfactory," say the Russians.

I spy—The Soviet admittedly is an avid watcher of U.S. satellites. During 1965, 59 visual tracking stations and 26 photographic tracking stations took part in this activity. In all about 100,000 observations of 128 satellites for 22,700 orbits were made. Nearly two-thirds of these observations were of U.S. satellites, excluding *Echo I* and *II*.

The scientists also claim progress in observing satellites by means of television. While tracking the *Luna X* space station it was possible to detect directly on the kinescope screen two moving objects—the station and the rocket carrier—whose positions were repeatedly fixed, say the Russians. ■

Aerojet Producing Bomblet Dispensers

Lightweight ordnance dispensers are shown being readied for shipment to the Air Force after being manufactured at Aerojet-General Corp., Downey, Calif. Known as the SUU-14/A, the dispenser can be carried by the T-28, B-26 and A1E propeller-type aircraft, operating at low altitudes and at speeds up to 400 knots.

Test Ban Treaty Safeguard Funding Judged Inadequate

Rep. Craig Hosmer (R-Calif.) claims that declining Atomic Energy Commission/Defense Dept. expenditures in support of nuclear test-ban treaty safeguards may be weakening U.S. strategic posture.

Hosmer, commenting on the Fiscal Year 1967 budget requests, reports that of four so-called safeguards set up to insure against the U.S. being victimized by abrogation of the agreement by any of the other signers, all but one has declined in total funding.

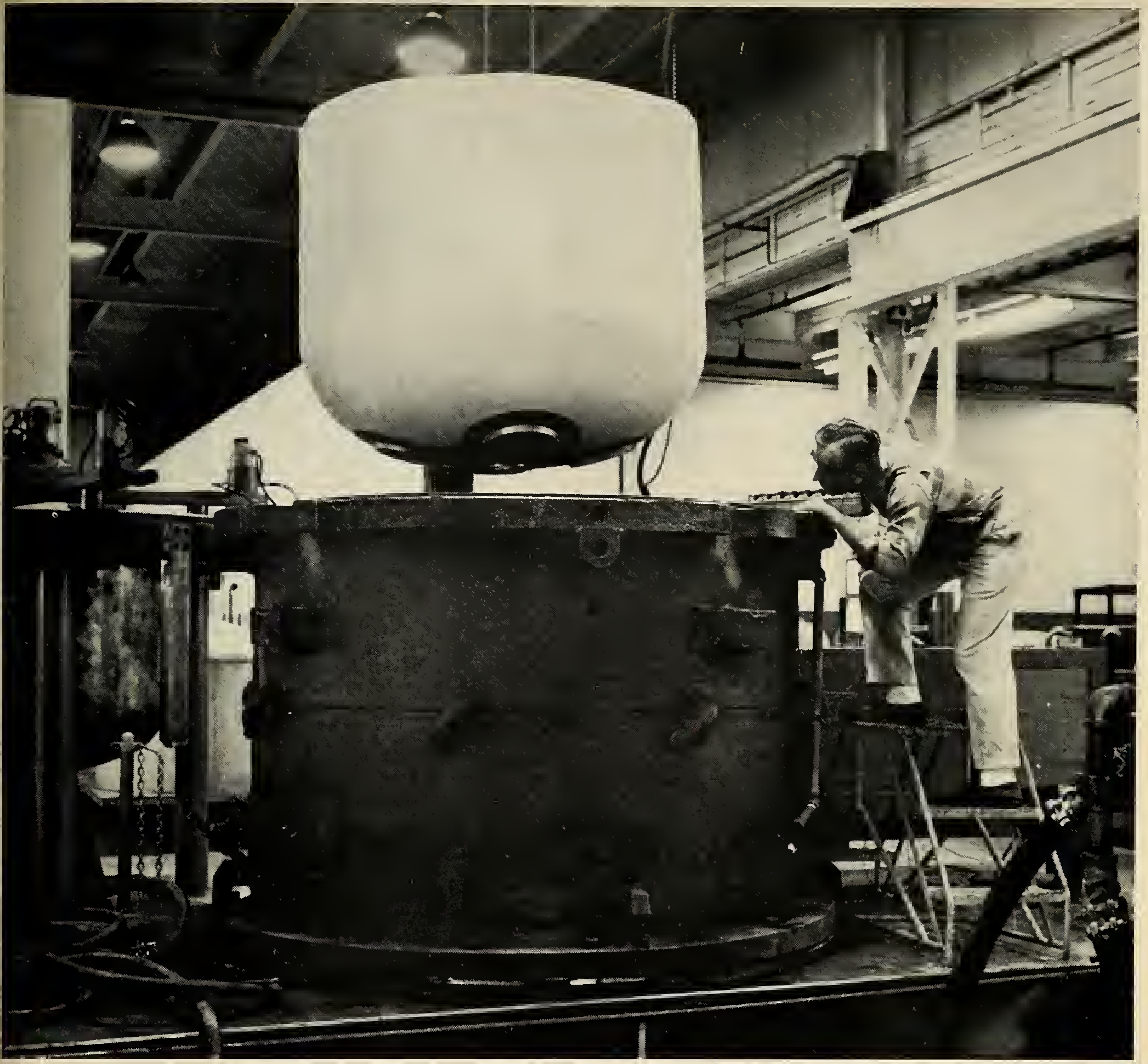
Only expenditures for monitoring Sino-Soviet actions have increased. Spending for underground testing, maintenance of in-house laboratory facilities, and standby capability to resume atmospheric tests has all declined from FY '65-66 levels.

While Hosmer offers no technical evidence that U.S. capabilities in these areas may be slipping, he believes there is a direct relationship between the level of funding and maintenance of these capabilities. Hosmer told MISSILES AND ROCKETS he was especially concerned about the reductions in the underground test and in-house laboratory budgets (a drop from $213.6 million to $196.9 million in the former, and $310.1 million to $298.5 million in the latter from FY '66 levels).

In particular, the California Congressman believes that lack of growth in these areas may be affecting development of a nuclear warhead for the much-debated *Nike-X* missile systems.

Hosmer told M/R that the combination of an underground test program which he believes is less aggressive and comprehensive than the one promised while arguing for the nuclear test ban, and some abortive U.S. high-altitude tests held before the treaty may result in having a "1962 warhead on a 1970 anti-ballistic missile system, if an ABM is ever deployed."

Hosmer says a series of scheduled high-altitude nuclear detonations early in 1963 involving missile launchings from the Johnston Island test site in the Pacific resulted in several failures and mission aborts. He believes these flights may have been directed at testing an ABM warhead.



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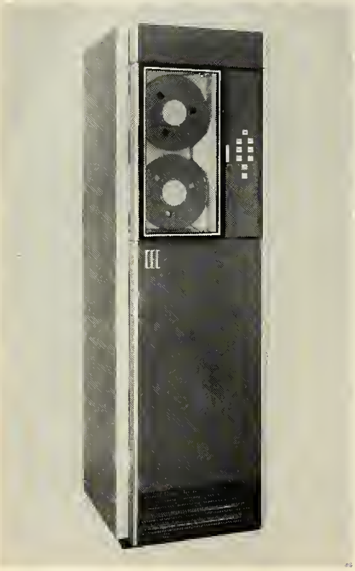

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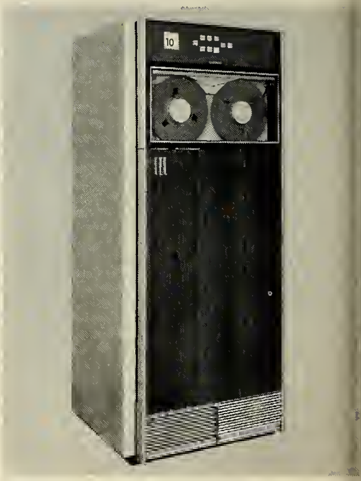

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Technical Countdown

ELECTRONICS

Multiple Camera Recon Probed

Cornell Aeronautical Laboratory, Inc., is developing a new aerial photo-reconnaissance system which greatly extends the basis for photo analysis. Funded jointly by the Air Force and the Advanced Research Projects Agency, the system consists of multiple cameras which simultaneously record any given scene in several photographic modes on a variety of film types. Ten narrow-band cameras selectively record the spectrum of interest while four oblique cameras view the ground from several angles. In addition, one panoramic camera gives large-area coverage and two others provide conventional coverage in color and black and white. The system has been successfully tested in appropriate environments of terrain and subjects, the laboratory reports.

Frequency-Based Clock Operational

A prototype model of a microelectronic digital clock was delivered to the U. S. Naval Research Laboratory May 3 by Federal Laboratories, a division of International Telephone and Telegraph. Designed to provide precise time-of-day and elapsed-time information for the research model of NRL's centralized electronic control system, the clock derives its accuracy from an external 1-megacycle-per-second frequency source. By counting and accumulating 1-second period counts in three time accumulators, the clock functions as an elapsed-time counter. The time accumulators are automatically synchronized and automatic error-checking and fault-location circuits are incorporated within the clock.

ASTRONAUTICS

Desert Studies Slated for Mars Information

Exploration of a Chilean desert may aid the U.S. development of Martian life-detection techniques. Richard W. Davies, Roy E. Cameron and Roy Brereton of NASA's Jet Propulsion Laboratory will study soil samples of the Atacoma Desert, which resembles the dryness of the Mars' terrain. Davies, leader of the May-June expedition, said JPL efforts will concentrate on the Calama plateau, where no rain has fallen within memory of any living resident. Approximately 1,000 lbs. of Atacoma soil will be sent to JPL, where extensive tests will be conducted to determine the existence of plant life. "The desert may harbor organisms that have heretofore been undetected because no one has persisted in the search for unusual species," said Davies. Some scientists, such as Norman H. Horowitz, chief of JPL's bioscience section, believe that colder deserts will produce evidence more useful to Mars exploration. Since Antarctica is the only land mass on Earth as cold as Mars (mean temperature of −130°F.), JPL will also sponsor an expedition to Victoria Land in December.

SUPPORT & EQUIPMENT

Multi-Environment Rover in Development

TerraStar, a multi-purpose vehicle for applications in oil and mineral exploration and production operations, is being designed by Lockheed Aircraft Service Co., Ontario, Calif. The vehicle will operate efficiently on paved surfaces, mud, swamps, and water by means of a multi-environment running gear. The gear consists of major-wheel assemblies, each having three minor wheels on secondary axles located radially about the major-wheel axle. Minor wheels propel the vehicle on hard ground and major wheels are used over mud or soft-soil environments. Lockheed said TerraStar is planned for use in telephone and power line patrol, cargo transport and rescue and fire-fighting operations.

MATERIALS

BuMines Tests Tungsten Electrowinning

Production of pure tungsten electrolytically may result in a lower price per pound of the heavy metal. Bureau of Mines scientists have dissolved tungsten oxide in a molten salt electrolyte. The passage of electric current through the bath causes tungsten to collect at the cathode. The process operates at 800° C instead of 1,000° C, the temperature of current commercial production methods. Electrowinning has been used in producing magnesium, aluminum and other metals. The BuMines work only establishes the feasibility of the approach with tungsten. Actual cost figures have not yet been determined.

Radiation Shielding Material Produced

A lead-concrete material, which has a density approaching solid lead, has been developed for use as shielding against photon radiation by the Chemtree Corp., Central Valley, N.Y. The material is completely formable and can be installed easily in volume, the company reports. Composed of mortar and lead shot, or other lead aggregate, the material is said to have a density of approximately 10 g/cu. cm. The mortar is supplied in dry-powder form, ready for mixing with water and the lead aggregate.

SPACE MEDICINE

Humans X-rayed Under Vibration

A high-speed device built by Admiral Corp. is being used at the Aerospace Medical Research Laboratories, Wright Patterson AFB, Ohio, to record motion X-rays of human beings exposed to vibration and impact stresses. The first of its kind, the Admiral system overcomes the problems previously encountered because of the extremely high radiation dosage levels which would be encountered for repetitive filming. The system is a cineradiograph in which a television camera and intensifying screen replace the usual film camera. The ultra-low light level image orthicon tube in the TV camera is matched to the spectral sensitivity of the intensifying screen, allowing acquisition of a single X-ray at a maximum exposure dosage of about five milliroentgens. Average clinical X-ray's dosage is 400 milliroentgens.

Radiation Immunization May Be Developed

Cornell Aeronautical Laboratory scientists report good results in the partial immunization of mice against radiation effects, through the use of the enzyme urease or using antibodies from rabbits which have been inoculated with urease. In nine experiments with 657 animals, two Cornell scientists found that 800 roentgens of cobalt gamma radiation produced an 80% mortality rate in untreated mice and only a 30% rate in treated mice. While all untreated mice were killed at 900 R, 20% of the treated mice survived. The urease used was extracted from the jackbean.

100% Oxygen Safe for Rats at 8.7 PSI

NASA scientists at Ames Research Center, who have been studying the effects of pure oxygen at various pressures with an eye to space use, report that rats have survived 64 days in pure oxygen at 450 torr (8.7 psi) with no signs of distress during the experiment. After sacrifice and pathological studies of the rats, it was determined that there were no significant differences in food and water consumption or demonstrable histological and hematological differences.

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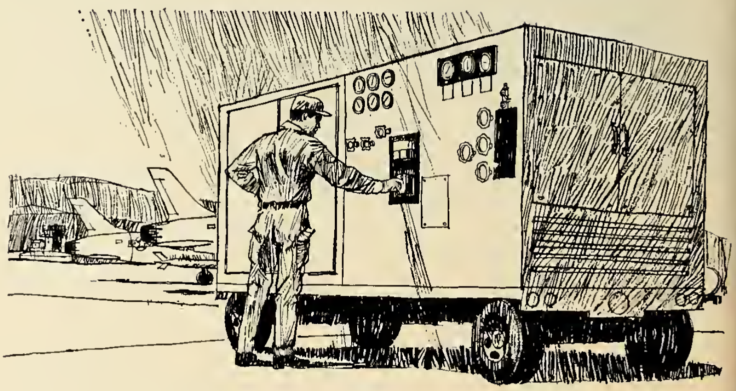

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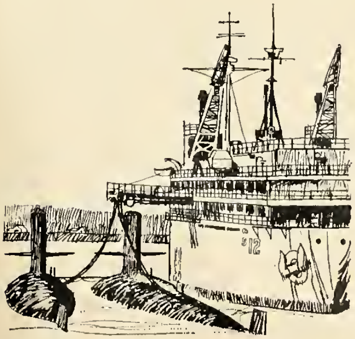

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GENERAL DYNAMICS
Star II
GENERAL DYNAMICS
Star III

Star II, left, and Star III shown at U.S. Naval Underwater Sound Laboratory, New London, Conn.

OCEANOLOGY

G/D Courting Research Sub Market

by Robert W. Niblock

Groton, Conn.—With the simulaneous launch of two undersea research vehicles—Star II and Star III—the Electric Boat Div. of General Dynamics Corp. recently gave public notice that t is seeking both identity and business n the new, still fuzzy research submarine market.

As a long-time builder of military ubmarines, the transition to construcion of the more exotic research submersibles is a natural for the shipbuilding firm—but the payoff is less mmediate than for its Navy-built subs. Potential buyers for these vehicles can be numbered on one hand. Electric Boat, like most concerns in the field, must, at least for now, count on lease greements to recoup investments.

Dr. John P. Craven, project manger of the Navy's Deep Submergence Systems Project (DSSP), has offered enouragement to all firms in the submersible business.

Speaking at the twin launching in New London, Conn., May 3, Craven aid that quantity production of submersible vehicles, "even as aircraft are produced today," is on the horizon.

The obvious questions in the buildrs' minds are how distant that horizon s, and for what purpose these vehicles will be used in quantity. Such imponderables are the substance of oceanology today and most industrialists echo the statement of an Electric Boat spokesman: "There's a lot of talk about oceanology potentials—but damn few dollars floating around."

Electric Boat has been more fortunate than some firms in landing contracts to build research submarines. Now under construction at the yard is NR-1, the first nuclear-powered research submarine, which will be used for ocean engineering projects. Electric Boat built the Ashera, once named the Star II, for the University of Pennsylvania, which uses it in underwater archeology projects; under contract from Reynolds International, Inc., the division built the Aluminaut—a large undersea vehicle able to operate to 15,000-ft. depths.

R&D emphasized—Still, most of the company's research vehicle activity and other oceanology efforts center in its research and development department. While actively seeking lease business for its vehicles, the company is said that the operational feedback from the new submersibles. One engineer said that the operational feedback from Star I and Ashera has "meant almost daily changes in vehicle construction, design and equipment because the technology is changing so fast."

Perhaps the first design modification in the gradual evolution of submersibles from observation and R&D platforms to "work boats" is the addition of more payload capabilities. Star III, a 24.5-ft. vehicle, will be able to take 1,000 lbs. to the designed depth of 2,000 ft. Potential lessees can now install their own instruments and equipment for test, evaluation and measurements in the depths. Much of the additional space on Star III is outside the pressure sphere in a void above the mechanical arm.

Also, the spheres of both new vehicles where operator and observers ride are relatively free of extraneous gear so that customers can also install equipment there. According to Alden W. Adams, operations manager of General Dynamics' Marine Technology Center at San Diego, Calif., operating experience with Ashera and Star I "has taught us to keep the boats as 'clean' as possible. Every customer wants to use his own equipment for his specific scientific project. They trust the accuracy of their own gear."

Electric Boat also regards the mechanical arm or manipulator as another piece of submersible equipment crucial to its work capabilities. Several manipulators and controls are now undergoing tests at the R&D department. The arm on Star III is designed for use in "underwater salvage, rescue, mining, construction, oceanographic research, and in maintenance of underwater oil-drilling equipment."

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14-in. linear reach and can pick up objects of all sizes up to 150 lbs. It stows in the hull while not in operation. Tools such as cable cutters, power nut drivers and adaptable socket wrenches are being developed for use with the arm. The company's mechanical arm specialists also are working on a prosthetic control arm, a device which fits the operator's hand and arm, and is controlled by up-and-down and lateral movements of the arm and wrist.

Electric Boat spokesmen say the manipulator work has been largely in support of the vehicle development but these devices will also be sold separately.

Logical progression—Dr. Herman E. Sheets, director of the 900-man Electric Boat R&D department, indicated that the work in deep submergence and other areas of ocean engineering and oceanography developed naturally, without addition of many new specialists or large expenditures for new equipment. New tasks in oceanography are similar in many respects to military submarine work, although specific problems are different, Sheets said. He feels that the company's experience in meeting safety requirements for military submarines has carried over into the submersible work—an aspect, in his opinion, which will enable Star II and Star III to meet safety certification standards if leased by the Navy.

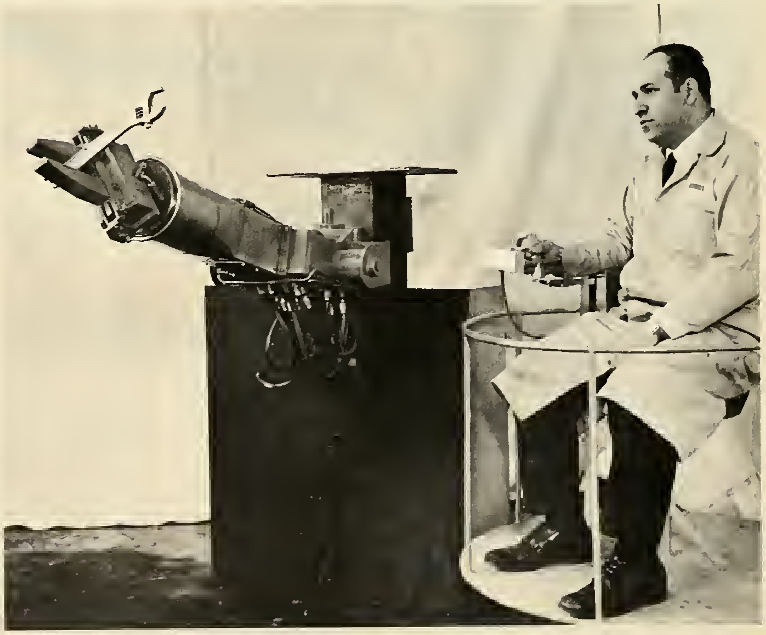
One of the unique features of Star III construction is a "hung" pressure sphere in a tubular framework. The 5-ft.-dia., HY-100 steel sphere is held in place by eight stainless steel straps. Advantages of this design, cited by Raymond L. Loughman, chief of underwater development engineering, include ease of sphere removal for maintenance —or for replacement by a higher-strength sphere if deeper work is desired with the same vehicle. The technique also means fewer welding requirements on the sphere itself.

The two vehicles are already undergoing water tests, beginning in the Thames River off the yard site, then out into deeper Atlantic water where they will be taken to their respective design depths.

Although no details were provided, it appears the company expects to land contracts that will have both Star II and Star III working on the East Coast, at least for the summer. Electric Boat officials indicated that contract announcements might be expected in the next few weeks.

Sheets said the two submersibles together cost about $750,000, which is probably a conservative estimate and does not include many of the research and development expenses that can never be accurately tallied.

The 17.7-ft. Star II, designed for dives to 1,200 ft., will lease for $6,000 per week, including an operator and two support personnel. Weekly lease bill for the larger Star III will be $10,500, including three personnel. The company is not offering a surface support ship in the lease package but it has a 290-ton



Mechanical arm developed by the Electric Boat Div., General Dynamics Corp., is demonstrated to show how it can hold tools to perform work in ocean depths. The arm was developed by the nuclear sub shipyard for use on undersea research vehicles.

CONFIGURATION MANAGEMENT ENGINEER
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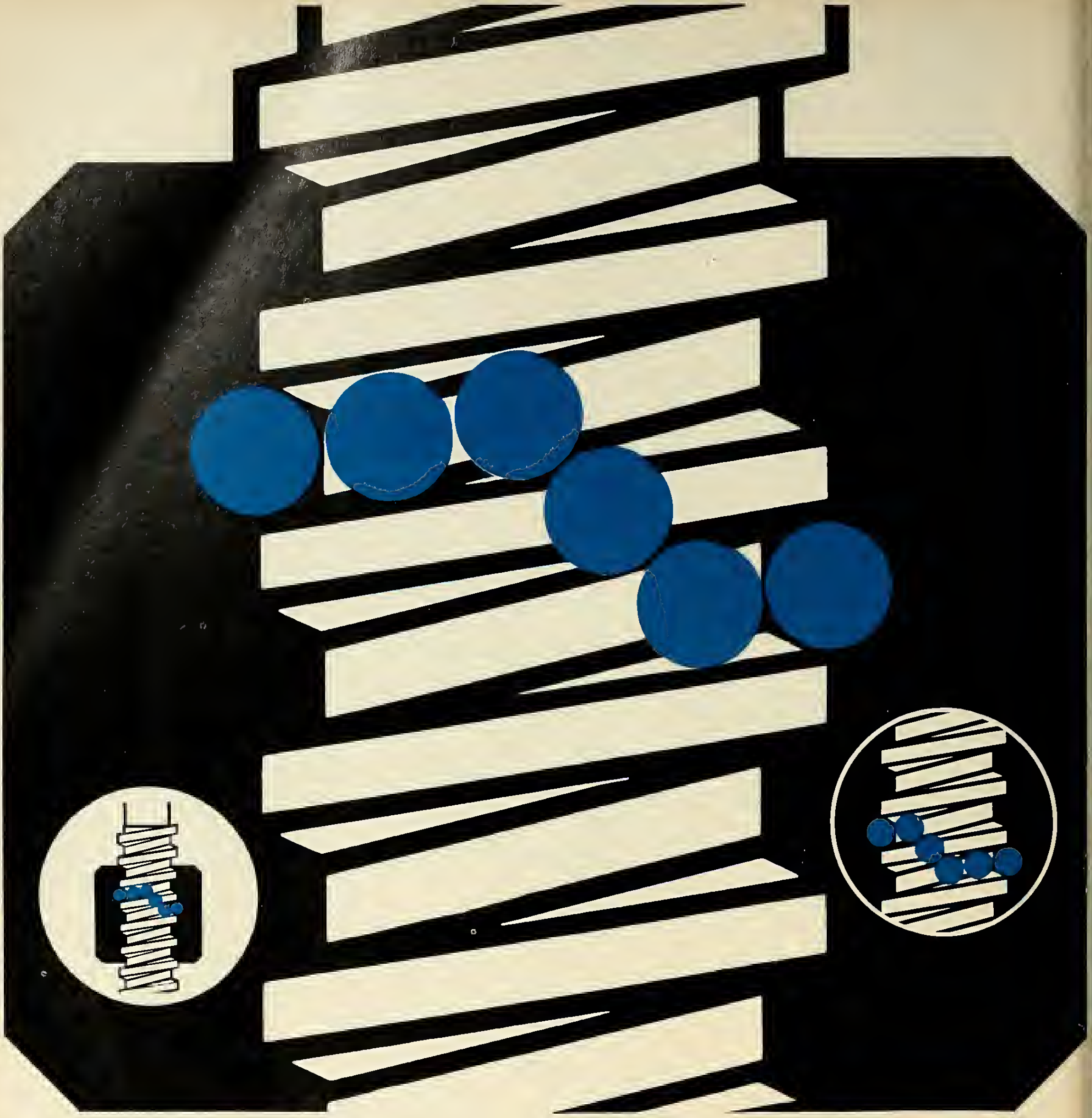

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Kidde Ballscrews do more than solve friction problems of prime movers and drives. They can solve size and weight problems, too—and meet the demands for high efficiency transfer of motion and power. Here's why:

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To solve these major problems, Kidde has designed a wide range of Ballscrew sizes—from units less than 1″ long to 32 foot custom assemblies. From 6″ diameters down to 1/8″; sizes 3/16″ to 1-1/2″ (with various lead) are stocked.

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research vessel, Sea Surveyor, equipped with a 12-ton crane, on the East Coast. This can be provided at additional expense. A smaller support vehicle called Sea Serpent is at the Marine Technology Center.

Navigation technique—Electric Boat will be trying a new underwater navigational system with Star II and Star III operations. Two transponders will be placed on the ocean bottom where vehicle operations are to be conducted. The transponders can be interrogated by equipment on Star III; the range to the transponders is then digitally displayed for the operator. Interrogation equipment will be placed on Star II as well. Al Stover, one of the company's submersible operators, said he thinks the navigation method will be quite satisfactory from the operator standpoint. The submersibles will also be tracked at all times by surface support ships.

The "wet" payload area and mechanical arm in the front of Star III limit its forward vision, but the operator has two television monitors for cameras mounted in the nose and sail areas of the sub. A port low in the front of the sphere is situated for required viewing when operating the mechanical arm.

The Star II sphere is in the forwardmost part of the vehicle and offers an ideal viewing situation, in addition to a TV monitor, for operator and observer. The interior of each vehicle is similar to an aircraft cockpit, though less cluttered. The two-man Star III has a submerged endurance of 12 hours, a range of 12 to 15 miles and will be able to operate in stiff currents with its 5-knot speed capability. Star II, also a two-man submersible, has eight hours endurance, 10 to 12 miles range and a top speed of 4.5 knots.

Adams and William H. Ezell, assistant manager of development engineering for marine technology, told MISSILES AND ROCKETS that the firm had successfully tested submerged towing of the Ashera, and sees potentials in this method for countering the "interface" problem when moving to and from the diving sites. Ashera, said Adams, was towed at varying depths to 200 ft. without difficulty. The technique also may have applications to actual vehicle operations, possibly when there is a need to cover large areas at relatively shallow depths, such as in bottom contour surveys.

Progress outlined—Electric Boat's involvement in deep submersible work has moved fairly fast despite the lack of major outside funding. The firm's first vehicle, Star I, was purchased in June, 1963, from five company engineers who built it on their own time and at their own expense. The company then built the Aluminaut and the Ashera.

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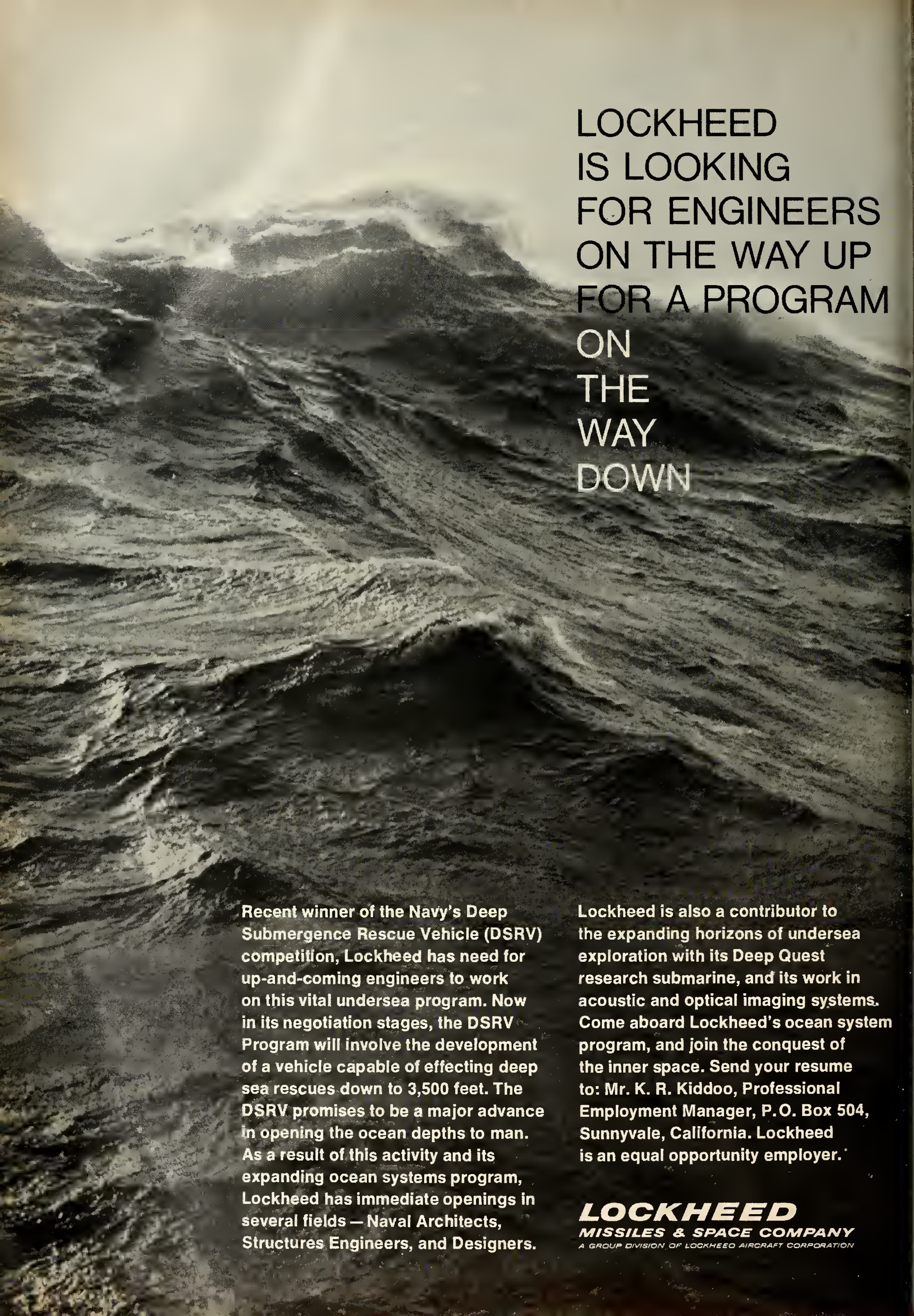

Recent winner of the Navy's Deep Submergence Rescue Vehicle (DSRV) competition, Lockheed has need for up-and-coming engineers to work on this vital undersea program. Now in its negotiation stages, the DSRV Program will involve the development of a vehicle capable of effecting deep sea rescues down to 3,500 feet. The DSRV promises to be a major advance in opening the ocean depths to man. As a result of this activity and its expanding ocean systems program, Lockheed has immediate openings in several fields — Naval Architects, Structures Engineers, and Designers. Lockheed is also a contributor to the expanding horizons of undersea exploration with its Deep Quest research submarine, and its work in acoustic and optical imaging systems. Come aboard Lockheed's ocean system program, and join the conquest of the inner space. Send your resume to: Mr. K. R. Kiddoo, Professional Employment Manager, P.O. Box 504, Sunnyvale, California. Lockheed is an equal opportunity employer.

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Sea Surveyor, a 290-ton oceanographic research vessel now in service with Electric Boat Div.

Those involved directly with the vehicles "get a little impatient at times," said Stover, "but in looking back, we are all a little surprised at the progress we have made."

One of several experiments conducted with Star I is testing fuel cells as the submersible power source under an Allis-Chalmers contract. The project "showed promise" but was not continued because Chalmers received a major space contract for fuel cell development. There are indications that Electric Boat is doing some work of its own both with fuel cells and radioisotope power sources. Exotic power sources like these may be the next major breakthrough in the submersible area.

Other projects within the R&D department include physical oceanography and marine biology studies in conjunction with the oceanographic department of the University of Rhode Island. Electric Boat also is working on some classified Navy projects in underwater acoustics. Sea Surveyor carries special equipment for acoustic tests and Loughman mentioned applications of submersibles in recording ambient noise level. The research vehicle is ideal for *in situ* ocean noise measurements because it can be muted while the measurements are made.

The Marine Technology Center opened less than a year ago and is thus far the main operations center for Electric Boat submersibles. It offers access to the sea and has a seaplane ramp that can be converted to a marine railway. There are pier faciliites for the 84-ft. Sea Serpent, and a 300-ft.-long model-towing basin. A model and instrumentation shop is adjacent to the towing basin.

Electric Boat and Ocean Systems, Inc., have a six-month Navy DSSP contract to develop a design evaluation package for the DSSP Large Object Salvage System (LOSS). The work began in February; DSSP representatives will go to New London in "a couple of weeks" to inspect a full-scale mockup of the deck decompression chamber (DDC) and the personnel transfer capsule (PTC), which was constructed under the auspices of the Electric Boat's R&D department.

DSSP work—Large objects by DSSP definition range in size "from submarines at one end of the spectrum through relatively small surface craft to cargo and passenger type aircraft" at the other. The objects "must have some recoverable value, either economic or intangible." An example of the latter is ascertaining the cause of an accident so that remedial action can be taken.

Keatings Keayes, who is managing the DSSP work for Electric Boat, said the combined study indicated that extended bottom living is not desirable for salvage work although long bottom stays may have many other applications. He notes that the diver's tasks in salvage work are "relatively short" and that it is undesirable for divers to be living in the salvage area when heavy rigging work commences because of dangers from dropped objects.

Using the PTC, divers can be lowered to the salvage site, do the necessary work and be returned to the surface ship without tedious and hazardous decompression in the water.

The design calls for a deck mating of the PTC to the DDC, which will be located below the main deck of a submarine rescue ship (ASR). The system is being designed for immediate use on existing ASR's and later on the new catamaran-hulled ships of this class. The system will be used for Sealab III.

When design specifications for the PTC and DDC are finalized, the first actual units probably will be constructed by a Navy shipyard. The system will be designed for salvage work to 600 ft.

Electric Boat officials could not reveal details on the NR-1, so named by Vice Adm. Hyman G. Rickover, USN, because he is convinced that once the ship is operational, "there will be a requirement for more of them"—or an NR-2 and so on.

In hearings before the Joint Committee on Atomic Energy at the first of the year, Rickover said: "I am trying to get this ship into operation in about a year and a half. I want to have it operating as soon as possible."

He expects it to be used first for exploration on the Continental Shelf and predicts "great impact for charting the ocean bottom." He also believes that vehicles like NR-1 will be "a great boon to the oil industry." ■

Tackling jobs like these takes systems know-how

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☐ Help Gemini astronauts steer by the stars
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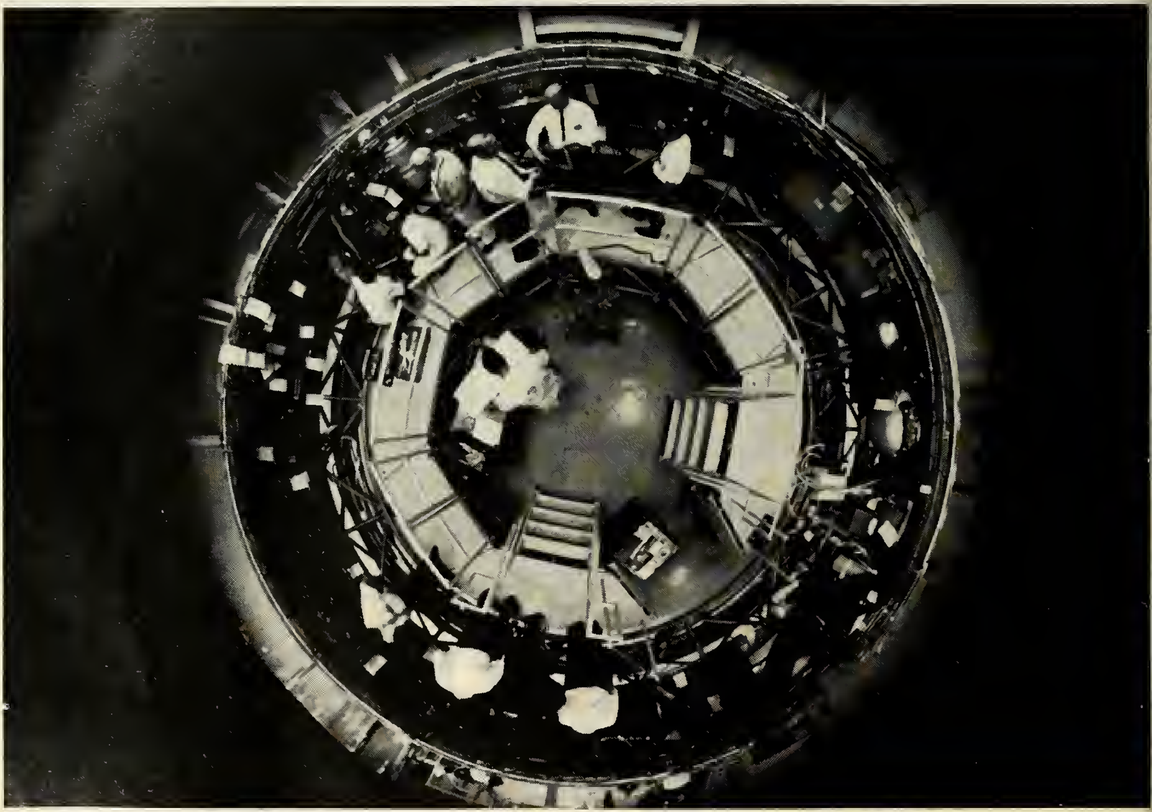

Managing development of Saturn's on-board control center. ☐ IBM is stage contractor to NASA's Marshall Space Flight Center for assembly, integration, checkout and launch support of Saturn IB and Saturn V Instrument Units. The Instrument Unit sits between the S-IVB vehicle stage and the Apollo payload. ☐ In response to the managerial and technical challenges of this critical part of the Saturn lunar mission, IBM built and staffed a 1500-man facility at Huntsville, Alabama in 18 months...and followed through by establishing a 550-man launch support team at NASA's Kennedy Space Center, Florida. ☐ The Instrument Unit is Saturn's control center. It controls and navigates Saturn's first, second and third stages before releasing Apollo for its lunar flight. ☐ IBM's management responsibility: integrate 67 sub-systems, supplied by 46 companies, into a single system to help boost Apollo to the moon.

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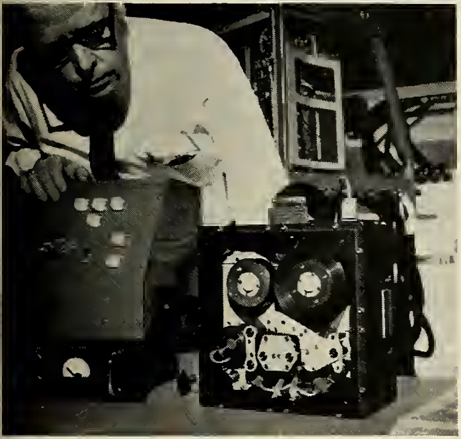
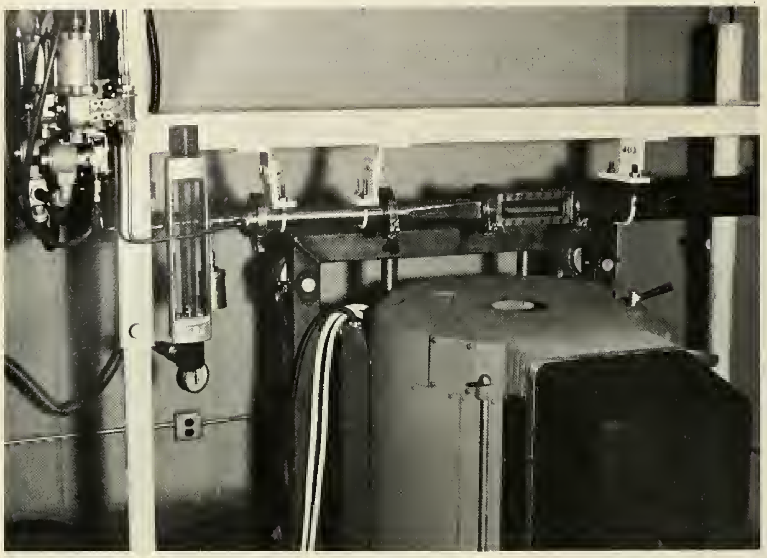


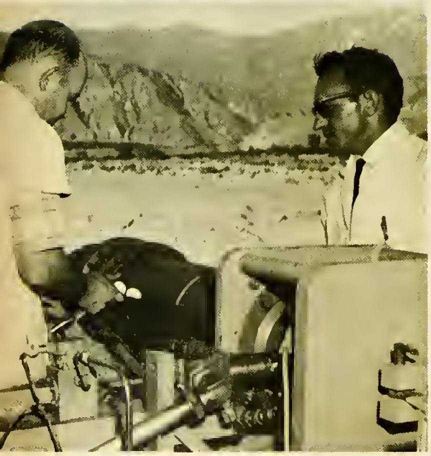
Helping Gemini astronauts steer by the stars. ☐ By expanding the capabilities of IBM's on-board computer system with a new Auxiliary Tape Memory. IBM's space systems team engineered a way for the Gemini computer to be reprogrammed in orbit by integrating the tape memory with the spacecraft's inertial guidance system. ☐ This 26-pound ATM unit gives the astronauts one million additional bits of information, 7 times more storage than within the IBM computer itself. This additional program power enables the crew to use data such as star fixes in the computer to determine Gemini's position in space. ☐ ATM can also furnish programs for the computer to indicate suitable landing sites several orbits in advance of re-entry. More memory capability means more ways for the astronauts to use the proven Gemini computer. ☐ ATM's contribution: more programs, more precise programs...and on-board at the astronauts' fingertips.

Engineering problem-solving devices for special jobs. ☐ At the Engineering Laboratory of IBM's Federal Systems Division. Systems and circuit experts develop modules to integrate standard equipment into powerful information handling systems. ☐ Their charter: advanced technologies and techniques, high-performance/low-cost, quick delivery. ☐ These engineers turn out solutions to the toughest systems problems...to increase data acquisition, display, communications, and processing rates. ☐ Among hundreds of installed aerospace and defense units are: tape switches, telemetry command units, network status displays, system selector controls and signal delay devices. ☐ The Engineering Laboratory also develops unique advanced devices...error correction units, message entry sets for battlefield use, sonar displays, film reading and recording equipment. ☐ IBM engineered problem-solving devices are at work in desert test ranges, in underwater laboratories, and on board aircraft, vans and ships.

Circle No. 9 on Subscriber Service Card

LPC Moves Toward Practical Hybrid





ABOVE: LPC's slab burner setup using Flexiglass fuel, visible through the quartz window at center. An arc-image furnace is used to provide high radiant heat input to determine radiant heat flux effect on hybrid fuel regression rates. Flourine and nitrogen control valves are at upper left. LEFT: Technicians adjust heavy-wall hybrid test motor prior to one of many test firings at LPC. Plumbing in foreground controls flow of liquid oxidizer. BELOW: Heavy-wall test motor serves as workhorse unit at LPC. Shown here in test firing, motor is used to check out various formulations of fuels and oxidizers in achieving optimum propellant combinations for given mission conditions.

by John F. Judge

Hybrid technology at Lockheed Propulsion Co. will be expanded to demonstrate a practical propulsion system tailored to mission applications under a $300,000 contract from the Army Missile Command.

This funding increment brings LPC's total contract amount from AMC to over $2 million. The follow-on contract calls for study of ballistic behavior under flight environments using the high-energy hybrid system developed under previous funding.

Lockheed will plan and initiate activities required for flight demonstrations following completion of the Army contract.

Combustion concepts—G. R. Makepeace, LPC vice president and technical director, says the firm has developed a regression rate theory which accurately correlates both convective heat transfer and pressure dependence. The correlations now used for reducing experimental data have universal application to arbitrary fuel grain geometries as well as to varying hybrid fuel formulations.

Consequently, says Makepeace, Lockheed has been able to scale ballistically from small-diameter motors to those with a larger diameter and of arbitrary fuel grain port geometry for any given fuel formulation with a high degree of accuracy.

For some seven years, LPC has been working on basic problems such as hybrid propellant selection and development, efficient fuel and oxidizer utilization, attainment of high combustion efficiencies, experimental and analytical establishment of hybrid fuel regression rate behavior.

Other areas included in the past work were the establishment and development of ballistic scaling relationships reflecting high confidence, component survivability and, finally, system demonstration through motor firings.

Three laboratory instruments were adapted by LPC to probe hybrid propulsion problems. These are an injection flow bench, a porous wall burner and a lab fuel slab burner.

Lab work past—The injection flow

Today's tank can be readily air dropped into battle—thanks to an idea for a new kind of aluminum armor that's lighter weight, yet tougher than ever. It's Alloy 7039, developed and tested—on our own ballistic range—by Kaiser Aluminum. It was chosen by the U.S. Army Weapons Command, over other aluminum alloys, to protect their newest assault vehicles.

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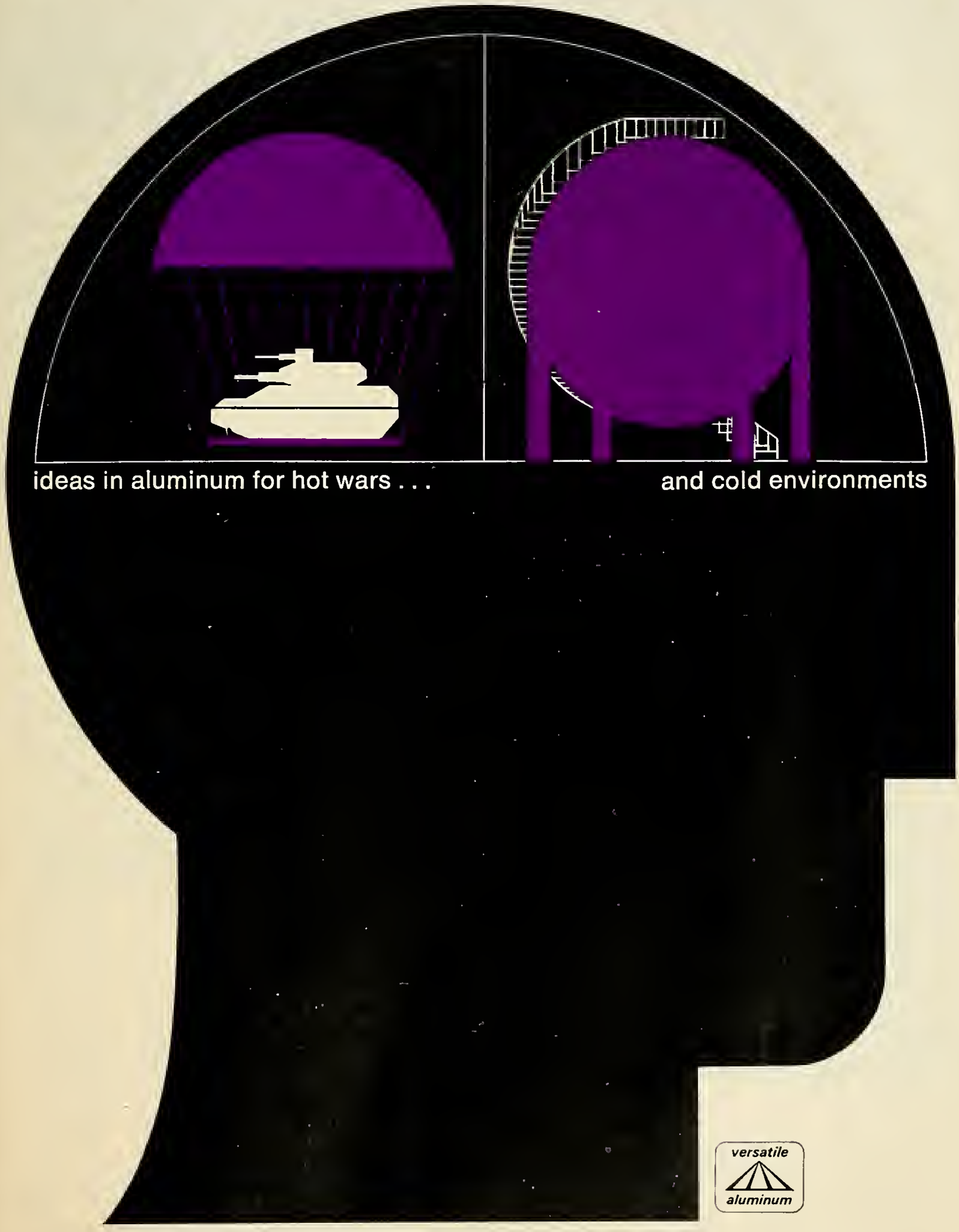
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bench, in conjunction with a computerized analysis of droplet evaporation phenomena, was used to establish effective droplet spray patterns and droplet size/distribution criteria for more efficient combustion.

An improved, compact turbulator —an internal mixing chamber for exhaust gases—was developed which reduced both weight and volume in the overall system. Recent tests have proven the feasibility of the design, says Makepeace.

Details of boundary layer processes and combustion mechanisms associated with hybrid combustion were examined with the porous wall burner. The slab burner provided verification of pressure dependence in a new fuel formulation after unexplained behavior was observed in motor firings, as well as yielding macroscopic information on fuel regression and fuel surface condition.

Makepeace says the engineering readiness of hybrids has been demonstrated and a unit with good energy potential must now be flown to show the immediate application of the concept.

Additional development should now be initiated to probe Earth- and space-storable hybrids. ■

SPACE SUPPORT

Wyle Facility Will Supply On-Line Saturn V Analysis

by Rex G. Pay

On-line analysis of the response of the *Saturn V* second stage (S-II) to high force vibration and to high-intensity acoustic fields will be achieved with a new data handling facility at the Huntsville, Ala., Testing Div. of Wyle Laboratories.

By use of precise timing and control, the facility can accurately interrelate the movements of up to 196 points. It thus makes possible a detailed examination of the dynamics of complex space structures before flight.

Typically, the system will enable test sections to be examined for structural mode shapes, force-field and response spatial correlations, high-acceleration-level locations or areas, and vibrational transfer characteristics, at all frequencies, at selected frequencies or averaged over specified bands of frequencies.

The equipment—Chief components of the new facility are a data conversion system and a Control Data Corp. 3200 computer capable of acquiring 100,000 data samples of 12-bit length per second.

Data are put into format and stored by the computer on digital magnetic tape for subsequent reduction. A 100,000-cu.-ft. reverberation room will be used for the S-II tests. Both sinusoidal and random response data will be collected.

According to Daniel J. Bozich, computer department chief at Wyle Laboratories, the overall system represents a major advance in the art of qualification testing. He points out, however, that the techniques developed are not restricted to environmental testing of structures but can be applied to acoustic and seismic investigations underwater and underground. That is, the same techniques have applications to oil and mineral exploration, communications, signal-source location, and target recognition.

A detailed description of structural vibration can be gained from sinusoidal response data. When the responses of two or more points are measured simultaneously, joint relationships between the points can be derived. These include transmissibilities, force-to-acceleration input and transfer functions, acceleration-to-acceleration input and transfer functions, input and transfer impedance functions, and spatial correlation functions.

Versatile data converters—To provide a capability of measuring such important joint properties, the Wyle data conversion system uses two synchronized analog-to-digital conversion channels, which take samples simultaneously.

Because of its large number of sampling channels, the system is also well suited to analysis of random response data. A statistical description of the amplitude characteristics of the

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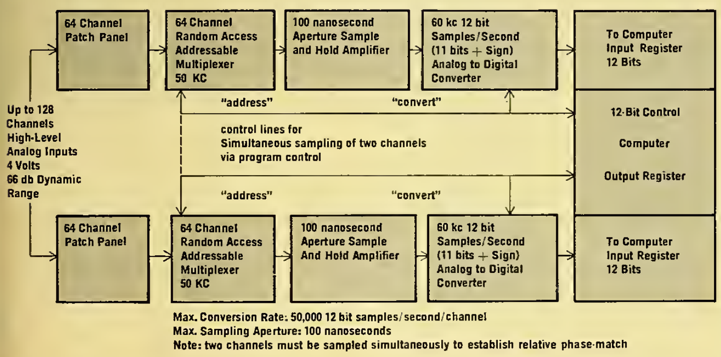
vibration data is obtained from the amplitude probability density function. The autocorrelation function and the power spectral density function yield time and frequency analyses of the data.

The system's ability to obtain data from two vibration responses simultaneously enables evaluation of joint amplitude probability density functions, cross-correlation functions, cross-power spectral-density functions, and several transfer functions. All this information is relevant to a description of how a structure vibrates in response to random forces.

Although basically a laboratory test unit, the system can, with suitable coupling via telemetry or tape, be used to acquire and analyze flight environmental data, including pressures, vibrations, accelerations, dynamic strains, and dynamic forces.

These data may be developed in laboratory tests from wide-band random excitation, sinusoidal sweep or step excitation, or sinusoidal resonance dwell excitation of the test structure. Sinusoidal and random signals with frequencies between zero and 10,000 cps can be acquired. Signals up to 25 kc are acquired with reduced accuracy.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"convert"
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12-Bit Control
Computer
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"address"
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60 kc 12 bit Samples/Second (11 bits + Sign) Analog to Digital Converter
To Computer Input Register 12 Bits
Max. Conversion Rate: 50,000 12 bit samples/second/channel
Max. Sampling Aperture: 100 nanoseconds
Note: two channels must be sampled simultaneously to establish relative phase-match

Sampling of two channels is synchronized to yield accurate relative phase data.

Operation described—The data-conversion system transforms analog signals two channels at a time into two 12-bit binary words. In its initial form, the system could sample up to 128 data channels or 64 pairs of data channels. Channel selection can be programmed to either addressable or sequential modes.

Two 64-channel Model 845E03 multiplexers produced by Texas Instruments enable the synchronized sampling of pairs of channels. These are solid-state time-division multiplexers accurate to ±0.02% full scale at the maximum 50,000-channel-per-second sampling rate.

The system has since been upgraded to handle 192 channels. For low sinusoidal frequencies or random inputs with a low cutoff frequency, the required data-sampling rate is low, and many channel pairs can be sequentially sampled within the same period.

Outputs from two multiplexers pass to two Texas Instruments Model 846-DIA-03D analog-to-digital converters with built-in sample-and-hold amplifiers. Maximum overall conversion rate per channel is 60,000 12-bit samples per second with an accuracy of ±0.05% of full scale. Each converter is a successive-approximation feedback-voltage encoder with a built-in precision reference and an integral sample-and-hold circuit system with a 100-nanosecond aperture.

A control unit interfaces the data-conversion system with the CDC 3200 computer's 24-bit input-output communication channel. In effect, the computer treats the data-conversion system as a peripheral device with input and output capabilities. As well as governing the transfer of digitized data, the control unit synchronizes the timing of the multiplexers and converters.

The computer's central processor transfers samples from its input register to a location within an allocated core memory buffer block on receipt of a "ready" signal from the controller. Repetition of the entire sampling procedure continues until the memory block is full. Data are then routed to a second memory block, while the contents of the first are transferred onto magnetic tape. The computer is coupled to four digital tape units, each of which has a maximum transfer rate of 60,000 6-bit characters per second.

collage

More Motorola Melange, continued from page 6

LOOKING FOR TECHNOLOGICAL BREAKTHROUGHS?

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How would you like to be part of the design team that developed equipment such as an error-control system that uses a shortened (16,8) cyclic code and features integrated circuits by the fistful. Who needs it? People involved in random error control on digital data links. If you're an engineer interested in joining a company investing its own money in such goodies, write our Chicago Center.

Remembrance of sweet Dora, the loved one

Remember DORA (AROD reversed), the Airborne Ranging Orbital Determination system? Well, the project is now under development in an abandoned (so to speak) Arizona mortuary. Our Western Center is bursting at the seams, and we have to take whatever space we can dig up, if you'll pardon the expression.

The Mating Game

What happens when you mate delta modulation with multiplexing? You get a rosy-cheeked Deltaplex, that's what. Which is exactly what we are midwifing. It's part of a tropo-scatter communications system. Without getting too involved, let's just say it provides a high quality communications link because is copes well with the time-varying transmission media of the troposphere... and tests for Rome ADC proved it. If this excites you, write Chicago Center.

Continued on page 50

Circle No. 13 on Subscriber Service Card

A random data-analysis computer program enables extraction of sample mean value, sample variance, estimated autocorrelation function, and estimated spectral density function. Additional programs compute amplitude probability density and distribution functions, skewness and kurtosis of the data sample, estimated cross-correlation function, estimated cross-spectral density function, and the joint probability density function.

The sinusoidal sweep data-analysis program includes computation of the frequency of source signals, amplitude of source and response signals, relative phase between any pair of selected signals, and transmissibility between any pair of selected signals. The analysis method automatically rejects harmonic response signals.

Outputs from the computer can be displayed on a Calcomp X-Y plotter at rates up to 300 points per second, or printed out on a Type 501 line printer, which delivers 1,000 lines per minute. The computer has a 16,384-word magnetic core memory, 24 bits per word, with a word cycle time of 1.25 microsec. Equipment to convert the computer to time sharing has been ordered. ■

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Douglas Cites Test Results Of Simulated Zero-G Study

by Heather M. David

WEIGHTLESSNESS and its effect upon the human body appear to lie somewhere between the effects of bed rest and submersion, researchers at Douglas Missiles & Space Systems Div. have concluded.

Studies aimed at deriving an exact comparison among the three are part of a number of projects in support of various Douglas projects in its advanced biotechnology department. Douglas manned spaceflight programs that contribute to the comparison include NASA's *Manned Orbiting Research Laboratory* (MORL) and *Apollo* Applications programs, and the Air Force's *Manned Orbiting Laboratory* (MOL).

Recent developments within the department have brought forth these results, in addition to a better understanding of the simulation of weightlessness on Earth:

—Helium, which is being considered for the *MOL*, poses a tough problem in that it ingasses into certain electronic parts such as vidicon tubes. However, calibrated thermal comfort tests at Douglas indicate an extremely high temperature tolerance for humans in this environment.

—High microbial populations stand as a major obstacle to the recycling of water for manned spaceflight life-support systems.

—Douglas scientists still believe that the unique conditions of weightlessness have a beneficial effect on human vision. A new testing device is nearing completion for flight use by NASA.

—Lower body negative pressure boots (LBNP) appear to have utility as testing devices for cardiovascular effects in weightlessness.

—A new magnesium-oxide system shows promise for both spaceflight and oceanographic purposes for carbon dioxide removal.

Weightlessness effect—Dr. W. J.

White, who recently conducted a series of tests comparing the effects of bed rest and immersion in silicon oil under a NASA contract, said that immersion causes a more severe cardiovascular and musculo-skeletal stress than bed rest.

Using the same measurements as for *Gemini* flights, the subjects in the tests were their own baselines, and were subjected to each stress—bed rest and immersion—for periods of 10 days.

Comparison of the data with medical data from the *Gemini* program indicated that physiological changes appear sooner and are more severe in immersion than during weightlessness or bed rest. Bed rest, in fact, was the least stressful of the three. These findings are expected to help greatly in evaluating results of ground simulations.

The silicon oil used by Douglas has since been found to have application in the care of badly burned persons, and may be a significant "fallout" from the program.

White plans to continue cardiovascular deconditioning work with more effort in development of negative pressure boots for flight use as testing devices. His concept is to put the astronauts in the LBNP boot, with a negative pressure of 60-80 mm Hg., to see how weightlessness has affected the normal cardiovascular responses. The LBNP causes blood to flow to the lower half of the body in the same manner as does gravity.

Space cabin simulator—Engineers and scientists working with the Douglas simulator hope to close the water cycle in the development of life support systems sometime this year, accomplishing Phase II of the long-range plan.

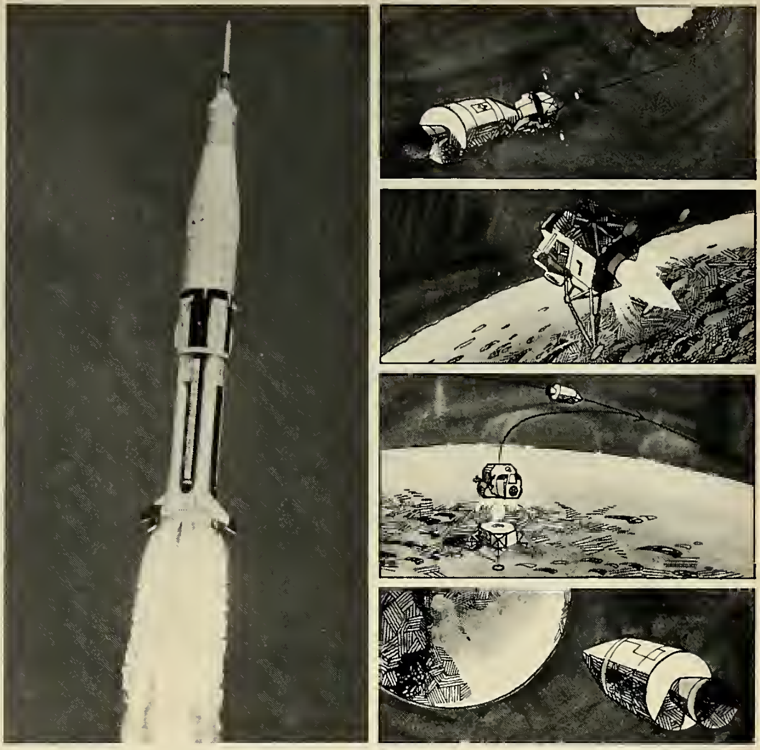
However, preliminary tests have indicated that this may be a greater problem than originally thought. While no illness resulted during a recent short run, considerable numbers of "dead bodies" were found in the treated water, causing some concern.

In this test, waste water was put into the reclamation system in a "dirty" form, to see if the system would purify it without pretreatment equipment. When this was found to be impossible, a pretreatment method was used, but was found to corrode the system.

Other processes are being studied to find a pretreatment method with the least weight and complexity penalty.

Helium problem—A recent five-day test, in which a 5 psi, helium/oxygen atmosphere like that being considered for *MOL* was studied, indicated that helium may present problems with electronic equipment.

Douglas is looking at the possibility of constructing vacuum tubes in such



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Dick describes Marquardt as an ideal environment where creative engineers can apply their abilities to a broad range of project assignments, "from paper studies to production." In addition to his project activities on the development of small attitude control rockets, his work has included development and testing of the world's first liquid air cycle engine, orbit calculations studies, ejector ramjet research, ballistic vehicle trajectory studies, rocket thrust augmentation, rocket heat transfer, and studies on detonations with hypergolic fuels.

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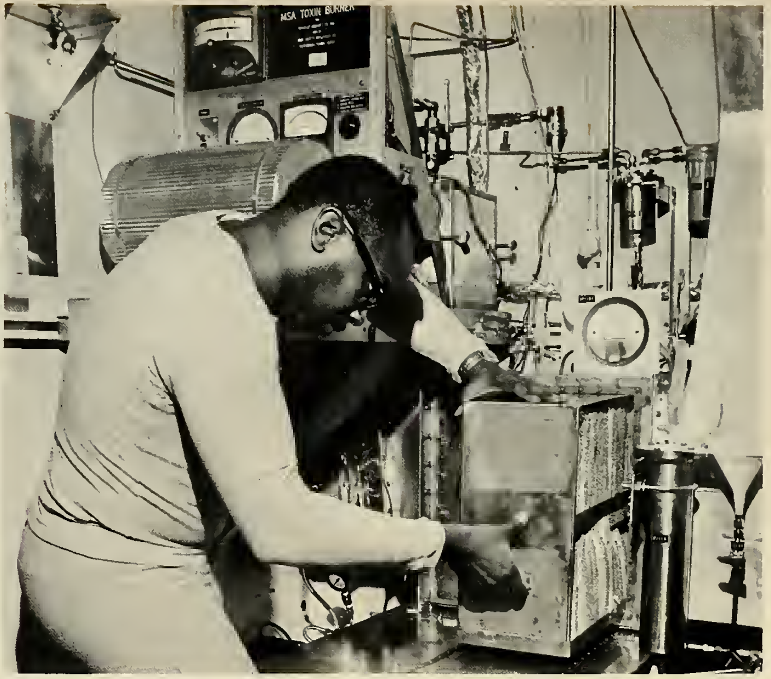
Technician replaces wick in air-evaporation water recovery system during simulation.

a way that they will not be "poisoned" by the gas seepage. The scientists reported that one vidicon tube was lost within 20 hours, and other components were sensitive.

The department plans to do further testing in the same atmosphere to validate its findings that subjects can endure much higher temperatures, such as from 82° F ± 9°, with the use of helium as a diluent in the 70/30 environment at 5 psi. A one-day test of various ventilation rates is planned.

Oxygen system—Douglas Life and Environmental Branch Chief Terry Secord told MISSILES AND ROCKETS that the molecular seive worked perfectly in the recent 5-day test. Originally constructed by TRW, Inc., the unit has undergone three iterations. The next step, he said, will be to make it compatible with an oxygen processing system, such as a Bosch reactor or other unit. Sometime in the future, he said, an electrolysis system would then be added to complete the oxygen cycle.

Douglas probably will purchase a Bosch system in the near future, or buy components to construct it in-house. The ultimate goal will be to demonstrate the system for a year, with 90-day resupply periods.

Another subsystem being developed at Douglas, is showing promise as an alternate to the molecular seive system.

The magnesium oxide carbon dioxide-removal system now has a weight efficiency of 40%, although the test unit has not been scaled up to human-size as yet. The only drawback of the system is that it requires 250° C to desorb the unit, but this could be overcome with isotopic power or a waste heat source, Douglas engineers say.

The unit has great applicability for underwater use as well, the Douglas group said, since moisture enhances the action. It could easily be recharged in a submarine, they say. The unit will be demonstrated in a man simulator before actual installation in the simulator for comparison with the molecular seive.

Goal of the Phase II simulator program is to run the systems to 45 days. Modifications will then be made to extend the system for Phase III, or a one-year life support operation.

Oculometer—White's group is perfecting a visual test for orbital testing to establish definitely whether improved vision may be a result of spaceflight. Earlier experiments by the same group indicated there may be improvement (M/R, Sept. 9, p. 22).

The present unit automatically records the user's ability for brightness, absolute threshold and flicker discrimination and visual acuity, with computer analysis. Flightweight hardware is being delivered to Ames Research Center.

Another phase, White said, will be to add tests for color vision and depth of perception. Tests are being made with both normal and defective-vision subjects to see how sensitive the device is in recording variations. ■

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IBM Urges Three Core Labs for AAP

BETHESDA, MD.—A long-range plan for three permanent space stations, or core laboratories, has been developed for NASA by the Federal Systems Division of International Business Machines Corp.

The orbiting research laboratory (ORL) package recommended by IBM after the space agency-funded analysis could get its first funding from the *Apollo* Applications Program now being readied for presentation to Congress with the Fiscal Year 1968 budget request.

Included in the IBM recommendation are: 1) an Earth Sciences and Resources and Atmospheric Science and Technology Laboratory in low-altitude (about 200 n.mi.), near-polar orbit (75 degrees); 2) an Astronomy Laboratory at the same altitude but at the minimum energy inclination of 28.5 degrees; and 3) an Engineering and Operations Laboratory, principally to support communications and synoptic meteorology experiments, at a near-synchronous altitude (like *Syncom II*).

Before each core laboratory was launched, two to four precursor support flights of about two weeks each would be made to develop the necessary extravehicular activity and operations techniques. Once the laboratories were in orbit and manned, data packages would be sent directly to Earth (instead of telemetering data) about once a week, due to the high resolution demanded by some observations. Between resupply periods, the laboratories would operate unmanned.

Dividends foreseen—IBM did not supply new cost estimates for the AAP portion of an ORL but the appendix of its report included a summary of last summer's IBM report on Earth-orbital mission definition in which the pricetag for a 15-flight program carrying 99 experiments was estimated at $693 million for the experiments themselves and $176 million for two new supporting facilities. Added to this would be the cost of the 15 launch vehicles (seven *Saturn IB's* and eight *Saturn V's*) and the *Apollo* spacecraft.

Many times offsetting the cost was IBM's list of potential benefits from an ORL program. These included:

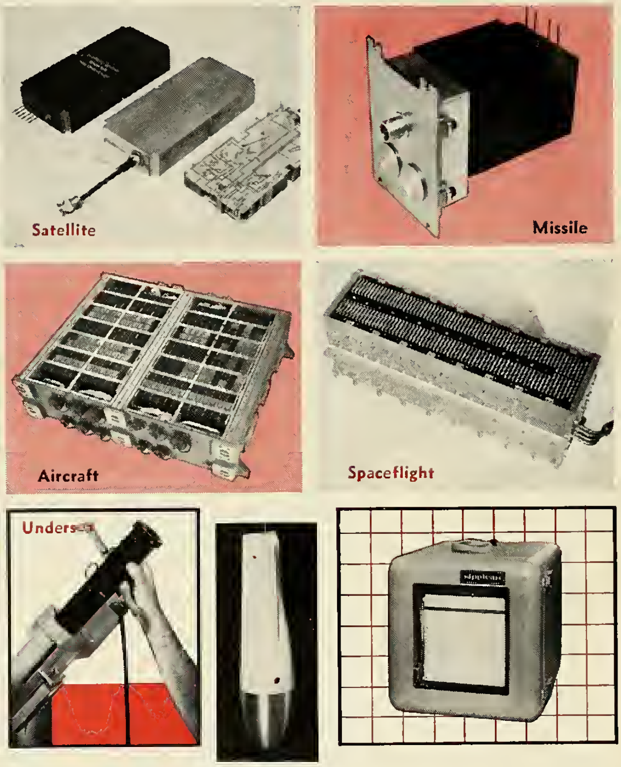
—Agriculture / forestry—estimated annual savings initially of $130 million throughout the world ($26 million in the U.S. alone) and $11 billion eventually ($840 million in the U.S.).

—Geology / hydrology—initially $620 million in the world ($170 million in the U.S.) and eventually $6 billion a year ($2.5 billion in the U.S.).

—Oceanography/marine technology—$800 million initially in the world ($350 million in the U.S.) and long-term annual benefits of $7 billion ($3.5 billion in the U.S.).

—Geography—$33 million initially ($9 million in the U.S.) and $800 million ($100 million in the U.S.).

—Atmospheric science and technology—$1 billion initially ($500 million in the U.S.) and eventually $83 billion ($29.5 billion in the U.S.). ■



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The Industry Week

Mergers and Acquisitions

Litton Industries, Inc., Beverly Hills, Calif., plans to purchase the assets of Jefferson Electronic Co., Bellwood, Ill., in a stock transaction valued at more than $6 million. The plan must be approved by Litton directors, Jefferson stockholders and the California Commissioner of Corporations. Jefferson produces specialized transformers and ballasts. . . . *Lear Siegler, Inc., Santa Monica, Calif., will take over the operating assets of Astek Instruments Corp., Grand Rapids, Mich. Directors of Astek, which is 84% owned by Lear Siegler, have approved a plan to liquidate the firm. Under the plan, Astek would be operated as a division of Lear. The plan will be voted on by Astek shareholders at a meeting June 1.* . . . Tracor, Inc., Austin, Tex., will purchase Micro-Tek Instruments, Inc., Baton Rouge, La., and the Robert L. Stone Corp., Austin. The two firms will form a nucleus for Tracor's entry into the analytical instrument field. . . . *Laboratory For Electronics, Inc., Waltham, Mass., has acquired the product line and inventory of the W.M.A. Andersen Co., Inc., Pleasant Valley, Conn. Andersen produces delay line test equipment.* . . . Control products, Inc., East Hanover, N.J., has acquired two switch production lines of Dynamic Controls Corp., South Windsor, Conn. . . . *Triplett Electrical Instrument Co., Bluffton, Ohio, has purchased the assets of Electronic Medical Specialties, Inc., Cleveland.*

New Activities

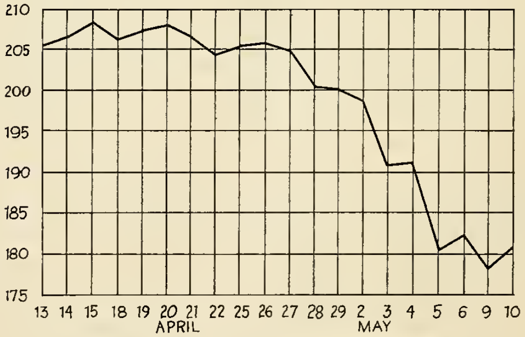
Rocket Research Corp., Seattle, Wash., has established a wholly owned subsidiary, Explosives Corp. of America. The firm will manufacture a new explosive, to be called Astrolite, based on advanced rocket technology and designed for both military and commercial applications. The explosive is believed to be the most powerful non-nuclear explosive ever developed, company officials say.Headquarters of the new firm are at 605 South Riverside Ave., Seattle. . . . *Vacco Valve Co., South El Monte, Calif., has changed its name to Vacco Industries.* . . . Sequential Electronic Systems, Inc., Elmsford, N.Y., has formed a New England R&D Div., in Newton, Mass. The new division will handle manufacture of analog and digital and synchro and digital converters and digital computers. . . . *Teledyne, Inc., Hawthorne, Calif., has combined its telemetry operations in a new organization called Teledyne Telemetry Co., headquartered in Princeton, N.J. The new firm consists of two divisions: The DynaPlex Div., Princeton, and the Aerospace Div., Los Angeles.* . . . Measurement Analysis Corp., Los Angeles, has established three operating divisions. They are Engineering and Instrumentation, Data Analysis and Computation, and Advanced Research and Special Projects. Purpose of the move is to extend techniques of random data measurement and analysis into new fields, such as aerospace, oceanography, biomedicine, seismology and meteorology.

Industry Facilities

Corning Glass Works is building a new plant near Canton, N.Y., to manufacture fused silica products. The 140,000-sq.-ft. facility will employ 200. Manufacturing operations are expected to start by the end of the year. An electronic components plant is also under construction by Corning in Wilmington, N.C. The 77,000-sq.-ft. plant is being built for the company's Electronic Products Div. . . . *Dynasciences Corp. is doubling the size of its Blue Bell, Pa., plant. The new facilities will allow the firm to rearrange its engineering, manufacturing and laboratory areas within an expanded 30,000 sq. ft. of floor space.* . . . The Hydrodyne Div. of Donaldson Co., Inc., is constructing a 22,000-sq.-ft. factory and office in San Fernando, Calif. The division manufactures precision filters, seals and bellows. . . . *Kahn & Co., Inc., has added a clean room to its Wethersfield, Conn., facility. The company fabricates test stands and equipment for aerospace applications.* . . . C. P. Clare & Co., Chicago-based manufacturer of relays and control components, has leased a new plant in Rapid City, S.D., with production to start by June. . . . *Reeves Brothers, Inc., will add a new 80,000-sq.-ft. plant to its industrial coating facilities in Rutherfordton, N.C.*

Missile/Space Stock Index

The Missile/Space Weighted Stock Index suffered large losses along with the rest of the stock market, falling to 177.86 on May 9. However, because of the much higher percentage of gain during the last year, the Index stocks still remain considerably above the prices at the beginning of 1965 when the Index was calculated at the first time at 100. By contrast, industrial stocks would have registered a figure of 101.96 on May 9, had they been calculated on the same scale as the Index, starting at 100 on Jan. 4, 1965. In addition to events in the automobile industry, which analysts said helped trigger the recent decline, Congressional action in adding funds to the President's budget contributed to fears of tax increases and also caused a wave of selling. Among these actions was the recommendation to add almost $1 billion to the Defense budget by the House Armed Services Committee.



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC. 31, 1964
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More Motorola Melange, continued from page 39

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Contracts and Procurements

AIR FORCE

$658,750—**North American Aviation, Inc.,** Autonetics Div., Anaheim, Calif., for design, development, test and fabrication of inertial measurement units for the SABRE guidance system.

$658,750—**General Motors Corp.,** AC Electronics Div., Milwaukee, for advanced development of inertial measurement units for SABRE guidance system.

$375,175—**North American Aviation, Inc.,** Rocketdyne Div., McGregor, Tex., for evaluation of solid propellants suitable for extended environments.

$269,994—**United Aircraft Corp.,** United Technology Center, Sunnyvale, Calif., for evaluation of high-energy binder.

$200,000—**IIT Research Institute,** Chicago, for R&D space decoy study.

$200,000—**Johns Hopkins University,** Baltimore, for high-resolution radars and ECM vulnerability study.

$184,700—**Ball Bros. Research Corp.,** Boulder Colo., to test and integrate biaxial solar-pointing controls and telemetry systems for research rockets.

$159,995—**Avco Corp.,** Research and Advanced Development Div., Wilmington, Mass., for updating specification of program definition phase for Mark 17 re-entry vehicle program.

$80,000—**Boeing Co.,** Aerospace Div., Seattle, for engineering to obtain high-temperature thermophysical properties of charring ablative materials.

$55,000—**Massachusetts Institute of Technology,** Cambridge, Mass., for analytical and experimental exploratory development in fluid concepts and techniques for advanced Air Force vehicles.

$50,200—**Westinghouse Electric Corp.,** Baltimore, for study of application of magnetic torquing for desaturation of control moment gyros in space vehicle control.

$28,000—**General Electric Co.,** Defense Electronics Div., Johnson City, N.Y., for research of fluid flywheel application to nutation damping of large space vehicles.

Northrop Corp., Nortronics Div., Palos Verdes Estates, Calif., for a large-screen satellite information display system for installation at Eastern Test Range Control, Cape Kennedy. Amount not disclosed.

ARMY

$10,709,569—**LTV Aerospace Corp.,** Michigan Div., Warren, Mich., for advanced production engineering for the *Lance* missile system.

$3,518,430—**Conductron Corp.,** Ann Arbor, Mich., to conduct classified research for Advanced Research Projects Agency.

$1,902,436—**Raytheon Co.,** Andover, Mass., for *Hawk* missile repair parts. Also $813,849 and $64,950 for *Hawk* missile repair parts.

$1,255,550—**Philco Corp.,** Aeronutronic Div., Newport Beach, Calif., to cover work for the *Chaparral* air-defense missile system.

$646,754—**Philco Corp.,** Newport Beach, Calif., for *Shillelagh* missile repair parts.

$345,377—**Raytheon Co.,** Andover, Mass., for product assurance for specific aspects of the *Hawk* missile system. Also $38,512 for reconditioning of assemblies for *Hawk*.

$265,836—**General Dynamics Corp.,** Pomona, Calif., for additional FY 1966 engineering services for *Redeye* weapon systems.

$132,140—**Belock Instrument Corp.,** College Point, N.Y., contract modification for a configuration management program for the *Hawk* simulator.

$95,595—**Planning Research Corp.,** Los Angeles, for study of employment of an advanced aerial fire-support system.

$27,950—**Welco Industries, Inc.,** Cincinnati, for repair parts for *Hawk* motor.

NAVY

$11,000,000—**General Precision, Inc.,** Librascope Group, Glendale, Calif., in two contracts for production of added antisubmarine weapon-control systems and instruments and for design and installation engineering services.

$3,662,041—**Sperry Rand Corp.,** Sperry Gyroscope Div., Great Neck, N.Y., for *Terrie* missile fire-control radar sets.

$199,375—**Muncie Gear Works,** Muncie, Ind. for facilities to be provided to the contracto to increase production of the 2.75-in. rocke nozzle and fin assemblies.

NASA

$266,109—**Space Ordnance Systems, Inc.,** El Segundo, Calif., from Manned Spacecraft Center, to develop and qualify a single bridgewir *Apollo* standard initiator.

$243,477—**Bell Aerosystems Co.,** Buffalo, N.Y., from Langley Research Center, to design, fabricate, install and test a one-man propulsion research apparatus.

$230,227—**GCA Corp.,** GCA Technology Div., Bedford, Mass., from Headquarters, for investigation of the D and lower E regions o the atmosphere.

$176,000—**North American Aviation, Inc.,** Space and Information Systems Div., Downey, Calif., from Marshall Space Flight Center, for electronic packages, environmental control systems and vehicle thermal systems integration.

$150,000—**Chrysler Corp.,** New Orleans, contract modification from Marshall Space Fligh Center, for optical technology for *Apollo* Applications Program.

$98,675—**General Dynamics Corp.,** Fort Worth, Tex., from Marshall Space Flight Center, fo cryogenic propellant stratification reductio techniques.

$89,603—**Stanford Research Institute,** Menl Park, Calif., from Ames Research Center, fo study of monocular visual accommodation.

$81,727—**Ardel Corp.,** Glendale, Calif., fro Manned Spacecraft Center, for performanc of tests to determine effects of space environment and re-entry conditions on parachut materials.

$49,417—**IIT Research Institute,** Chicago, fro Marshall Space Flight Center, for study o vibration induced in thin-walled pipes unde varying flow conditions.

$49,000—**Martin Co.,** Baltimore, addition to contract from Marshall Space Flight Center, fo continuing study of wind-induced oscillation on the *Saturn* rocket.

$48,186—**Physics Technology Laboratories,** L Mesa, Calif., from Manned Spacecraft Center for investigation of lunar soil modification du to bombardment of simulated solar plasm wind.

$38,700—**Varian Associates,** Los Altos, Calif. from Ames Research Center, for component and accessories for high-resolution nuclea magnetic resonance spectrometer.

$38,200—**Bell Aerosystems Co.,** Buffalo, N.Y. from Flight Research Center, for *Agena* rocke engine study.

$37,752—**Walter V. Sterling, Inc.,** Claremont Calif., from Ames Research Center, for stud of qualifying motion-generating flight simulators.

$35,300—**Cornell Aeronautical Laboratory,** Buffalo, N.Y., contract modification from Marshall Space Flight Center, for *Saturn V* shroud and fin interference, free static aerodynamic investigation.

$32,500—**Atlantic Research Corp.,** Alexandria Va., from Manned Spacecraft Center, fo Lunar Excursion Module propulsion system valve actuation tests.

$31,550—**Martin Co.,** Baltimore, from Langle Research Center, for study relating to th vibrator behavior of a thin-wall torus shell.

$29,616—**Allied Research Associates,** Araco Geophysics Co. Div., Concord, Mass., modification to existing contract from Headquarter for investigation of the feasibility of sea surface temperature measurements or temperature-gradient measurements from satellite.

$29,600—**Beckman Instruments, Inc.,** Fullerton Calif., from Ames Research Center, for detection of extraterrestrial microorganisms.

$28,496—**Philco Corp.,** Palo Alto, Calif., fro Ames Research Center, for investigation o the use of a radioisotope for space-environment simulation.

INDUSTRY

$1,700,000—**Sylvania Electric Products, Inc.**, New York City, from **International Telephone & Telegraph Corp.**, New York City, for special-purpose receiving equipment to be used in an Air Force electronic system.

$100,000—**Radio Corp. of America**, Electronic Components and Devices, Needham, Mass., from **Boeing Co.**, Seattle, to design, develop, test and produce a core memory unit for use in airborne launch-control data-processing equipment.

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Attn: Directorate of Procurement and Production
Hill Air Force Base, Utah

Engineering services for conducting the 10-year aging program for wings I through V *Minuteman* second-stage motor materials and components including performance of required testing, reduction and analysis of test data and submission reports. RFP no. 42-600-66-1315/Q—approx. RFP due date 5 June, 1966. A request for proposal will be issued to Aerojet-General Corp., Sacramento, Calif. For information only; RFP not available.

U. S. Navy Purchasing Office
3rd Ave. & 29th Street
Brooklyn, N.Y. 11232

RFQ N00140-66-Q-0311 on sole-source basis from Sundstrand Aviation Div. of Sundstrand Corp. for design, development and manufacture of two biliquid-propellant pumps for use with R&D torpedo vehicles SLAST (Submarine-Launched Anti-Surface Ship Torpedo). Material to be of a modified and improved design and compatible with pump furnished by Sundstrand Aviation for Torpedo Mk-48 propulsion system. For information only; RFP not available.

Negotiation Branch 1
Systems Contracts Division A
Procurement and Production Directorate
U.S. Army Missile Command
Redstone Arsenal, Ala.

Negotiations will be conducted with United Aircraft Research Laboratories, East Hartford, Conn., for an experimental study of the generating of narrow high-energy laser pulses. For information only; RFP not available.

Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135

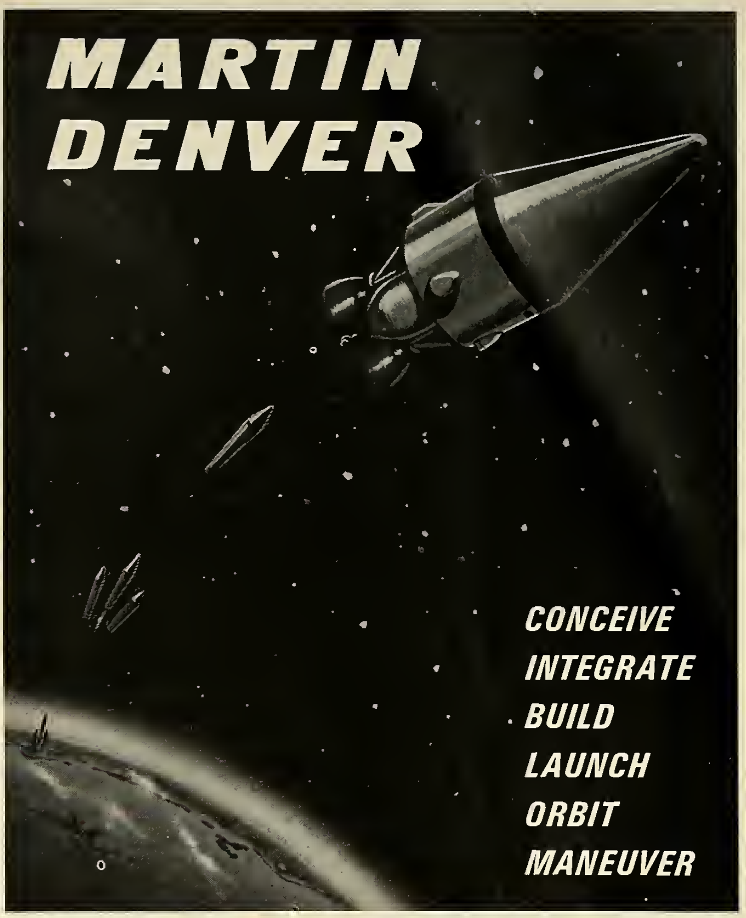
Negotiations will be conducted with Midwest Research Institute, 425 Volker Blvd., Kansas City, Mo. 64110, for an investigation of extremely high-vacuum technology. For information only; RFP not available.

Procurement and Production, Director
U.S. Army Edgewood Arsenal
Edgewood Arsenal, Md. 21010

Negotiations will be conducted with Esso Research and Engineering Co., Linden, N.J., for continued research studies covering "fundamental investigation of the catalytic degradation of hydrocarbon fuels." For information only; RFP not available.

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas

Maintenance and modification services for the NASA/MSC *Gemini/Apollo* simulator complex during the period Sept. '66 through Aug. '67. The services involve maintenance and modification of various astronaut-training equipment including *Gemini* mission simulators, *Apollo* mission simulators, translation and docking simulator, zero g simulator, Lunar Excursion Module mission simulator and various systems trainers and specialized equipment. NASA plans to negotiate with the incumbent contractor General Precision, Inc., Link Group of Binghamton, N.Y. For information only; RFP not available.



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Design, integration, test of biological, lunar, planetary and geophysical experiments for advanced space craft. Liaison with critical research groups to integrate experimental efforts.
- **PROPULSION SYSTEMS**
Experimental research in spacecraft and upper stage propulsion and pressurization systems, attitude controls, Zero-G fluids, plume analysis and high energy fuels.
- **SPACE ELECTRONICS**
Analysis and design of space vehicle command and control systems, Doppler radar, solar and fuel cells, micro-wave imagery, exposure meters, magnetometers, seismometers and cloud sensors.
- **OPTICS — INFRARED**
Design, analysis and test of TV, U-V, X-Ray, photographic and spectroscopic systems for advanced space applications.
- **SPACE LIFE SCIENCE**
Analytically determine mission requirements regarding extra/intra vehicular activity, life sciences, bio-medical physiology and man-machine relationships.
- **ADVANCED CONCEPTS**
Conceptual design and analytical criteria for space stations, upper stages, launch systems, payload integration and other related advanced space systems.
- **GUIDANCE AND CONTROL**
Design analysis of navigation systems, sensors, star tracking, horizon scanning, error analysis, flight controls, stability, launch and in-orbit conditions.
- **STRUCTURAL DYNAMICS**
Analysis and test involving vibrations, loads, buffet, gust, flutter, dynamic response and math modeling.

Send complete resume to **W. H. Thompson**, Manager of Personnel Staffing, Mail #6310

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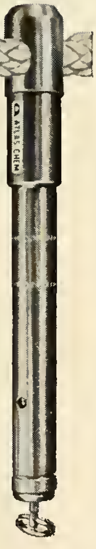

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Quick . . . cutters function in milliseconds.

Sure . . . one moving part. Operated by the contained action of a stable pyrotechnic compound that withstands temperatures from —65 to +160°F.

Full line . . . for cutting nylon reefing lines up to 12,000 lbs. test . . . steel rods and cables up to ¼-inch . . . electrical cables up to 2-inch. Available with built-in delays up to 20 seconds. Your choice of electrical, mechanical or pneumatic initiation. Send for complete technical information today. Or call area code 215 666-0700.

ATLAS
CHEMICAL INDUSTRIES, INC.
Aerospace Components Division
Valley Forge, Pa. 19481
Circle No. 20 on Subscriber Service Card

Products and Processes

Milliwatt Test Set

A milliwatt test set that is said to be half the size of previous models has been introduced by ITT Industrial Products Div.

The Model 74166-J meter features a compact metal case and pushbutton switching. The unit is fitted with a BNC connector and will make measurements of 1 to —1 db referred to 1 mw on 75-ohm unbalanced circuits at frequencies up to 30 mc. It will also measure heater voltages of 5.6 to 7v.

A wired-in thermocouple is used with heater impedance shunted down to 75 ohms. High measuring accuracy is claimed with a built-in miniature Weston standard cell, against which the circuit is standardized by a series of simple switching and adjusting operations. The standardizing circuit can also be used to send a d-c power of 1 mw into external 75-ohm circuits for calibrating other apparatus.

The device operates from three 1.5v dry cells housed in the case.

Circle No. 151 on Subscriber Service Card

Antenna-Coupling Systems

Two remotely tuned antenna-coupling systems have been developed by Delta Electronics, Inc.

Model HFAS-4B covers 4 to 30 mc and Model HFAS-9 covers 3 to 30 mc. Both systems match 50-ohm transmitter outputs to 35-ft. whip antennas. System components include a remotely controlled coupling network and a remote control. The remote console tunes the system either through manual adjustment of two potentiometers or by plugging in pre-set printed-circuit cards, each bearing two screw driver-adjusted potentiometers. Remote tuning is with solid-state silicon-rectifier d-c circuitry.

Power rating for the HFAS-4B is 5 kw average, 20 kw PEP; rating for the HFAS-9 is 1 kw average, 2.5 kw PEP. Efficiency of both systems is 90% or better from 4 to 30 mc, and 80% or better in the HFAS-9 from 3 to 4 mc. Both systems provide transmitter/antenna matching within resolution limits of the servo control system.

Circle No. 152 on Subscriber Service Card

Gas Analyzer

A gas analyzer that permits determination of dissolved gases in sea water on a routine basis is being marketed by Marine Advisers, Inc.

Model U5-A makes possible simultaneous semi-automatic determination of several gases from the same small sample of liquid (approximately 2 ml). Semi-automatic operation with repeatability is featured, together with de-

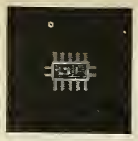
New Product of the Week: Superconducting Tapes

Strong and highly flexible superconducting tapes that will be sold separately or as part of complete magnet systems capable of producing fields greater than 100,000 gauss have been introduced by General Electric Co.

The material, used in superconducting magnets, consists of a half-inch-wide ribbon of niobium-tin foil laminated between two layers of one-mil-thick, tinned copper tape. The problem of niobium-tin brittleness is claimed to have been surmounted by means of the sandwich-type configuration of the tape, which is formed by diffusion heat treatment of a tin-coated niobium ribbon. The material suffers no reduction in its current-carrying ability at a bending diameter as small as 0.2 in. and a tensile load up to 20,000 psi.

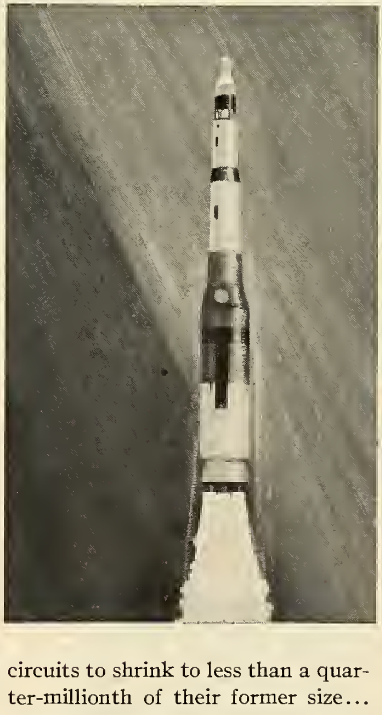
For additional strength, the tape can also be laminated with stainless steel. As a winding for coils, it requires no special heat treatment, and can be repeatedly wound and unwound without damage.

Circle No. 153 on Subscriber Service Card



A little

goes a long way



This is an integrated electronic circuit shown at actual size.

Though tiny, it plays a big role in assuring reliability in electronic systems for aircraft, missiles, and submarines. And it also goes a long way in reducing cost, weight, and size. It does the same job as seven normal-sized vacuum tubes...as well as a host of resistors, diodes, and other devices.

The integrated circuit is the key to microelectronics, the technological revolution now sweeping the electronics industry. It has helped electronic circuits to shrink to less than a quarter-millionth of their former size... while increasing systems reliability by a hundredfold.

North American Aviation/Autonetics Division designed and built the first successful microelectronics system using integrated circuits. It is proving itself in the Minuteman II missile.

Pioneering new technologies such as this is but one way North American Aviation contributes to the nation's growth and security. It is designing, building, and testing the Apollo spacecraft in cooperation with NASA; and built the Mach 3 XB-70 aircraft, a vital contributor to the nation's continuing leadership in aviation.

North American Aviation

Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Science Center, Space & Information Systems

experimental engineers *...for career positions in Connecticut and Florida*

Pratt & Whitney Aircraft is working on a variety of gas turbine programs for aircraft, marine, industrial and power generation applications, as well as extensive programs in such diverse technologies as fuel cells and liquid rockets. Because of this diversity, we require the knowledge and ability of engineers from many different disciplines.

For example, our current requirements in Experimental Engineering include openings for:

BSME's and BSAE's—for work in Current Engine Development, Electrical Machinery, Current Engine and Advanced Airbreathing Performance, Inlets and Nozzles, Fuel Systems Development work, Vibration and Stress Analysis, Acoustic Measurements, Heat Transfer, and Flow Dynamics Rotating Machinery.

MARINE ENGINEERS and NAVAL ARCHITECTS—for work in Turbo-Power and Marine applications.

CHEMICAL ENGINEERS—for work in Combustion Analysis, Mechanical Components, Advanced Fuel Cell Development, Fuel Cell Performance Analysis, Fuel Cell Fabrication and Testing, Reformer work, and Heat Transfer.

METALLURGICAL ENGINEERS—for work in Advanced Structures and in the manufacturing and development of Fuel Cell Electrode Materials.

ELECTRICAL and ELECTRONIC ENGINEERS—for work in Ignition, Industrial and Turbine Controls, controls in electrical systems associated with Fuel Cell Development, and Servo Controls.

In addition to pleasant living in either Connecticut or Florida . . . areas that offer a variety of neighborhood environments and an abundance of recreational advantages . . . you will benefit from good starting salaries . . . fully-reimbursed graduate study . . . an outstanding group insurance program . . . and a fine retirement plan. At P&WA, you'll find a solid engineering team, a unique departmental stability and demanding assignments with early responsibility. Because of expansion in our existing programs and the continual addition of new ones, Pratt & Whitney Aircraft offers career minded engineers exceptional opportunities for advancement.

Depending on your geographic preference, send your complete resume, including salary requirements, to either Mr. P. F. Smith, Pratt & Whitney Aircraft, East Hartford 8, Connecticut or Mr. J. F. Morton, Pratt & Whitney Aircraft, West Palm Beach, Florida.

Pratt & Whitney Aircraft

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termination of dissolved oxygen in concentrations as low as 0.3 ppm, rapid analysis, and hand portability.

The unit can be coupled with an optional integrating strip chart recorder to provide permanent records from which direct gas content may be derived by application of a calibration factor.

Circle No. 154 on Subscriber Service Card

Fluidic Devices

Two multiple-input fluidic devices for machine control have been introduced by Corning Glass Works. One device is a four-input flip-flop, the other is a four-input NOR gate.

The devices are manufactured with photosensitive glass. An image of a fluid channel network is developed in the glass, then etched partly away. The channels are enclosed by a cover plate or another layer of etched circuitry. The layers are then fused by heat, which also converts the glass into a stronger glass-ceramic material.

Operating principle for the flip-flop and NOR gate is wall attachment. Both are load insensitive and can fan out to four similar devices. Frequency response is more than 1,000 cps. Power nozzle pressure is 3 psig nominal, 20 psig maximum, and 1.5 psig minimum. Switch pressure requirement is 5 to 15% of the supply pressure, and pressure recovery is 33% of supply pressure maximum.

Circle No. 155 on Subscriber Service Card

Tungsten, Tantalum Crystals

Large diameter and high-purity tungsten and tantalum single crystals produced by electron beam techniques are being marketed by Materials Research Corp.

Randomly and specifically oriented

Missile launch site **Career launch site**

You will find many opportunities to launch an advanced phase of your career within Boeing's Aerospace Group. Regardless of your present status in the aerospace arts, assignments at your level are available in Seattle, Huntsville, New Orleans, Cape Kennedy, and Bay St. Louis (Mississippi), on a variety of programs.

Such opportunities exist, for example, on the USAF Minuteman II ICBM, for which Boeing is weapon system integrator. With a growing number of these missiles already installed and at the ready, company-funded research and development is proceeding on an even more sophisticated system.

The chance too, to work on National Aeronautics and Space Administration's Apollo/Saturn V manned lunar landing program is immediately available. Boeing is responsible for major elements of systems engineering and integration and is contractor for the design, fabrication, assembly and test of the S-1C first stage booster, the largest under development in the free world.

Another NASA project of interest to scientists and engineers is the Lunar Orbiter. It is designed to orbit the moon, seek out Apollo landing sites, and transmit sharp, detailed photographs of the lunar surface back to earth.

Positions on these programs require a B.S. degree or higher in an applicable discipline, with related experience preferred. Boeing is an equal opportunity employer.

Please address your resume to the Boeing Personnel Office, at the facility you prefer: **Cape Kennedy:** *P.O. Box 1698-MTZ, Cocoa Beach, Florida;* **Huntsville:** *P.O. Box 1680-MTZ, Huntsville, Alabama;* **Bay St. Louis:** *Mississippi Test Facility, Dept. MTZ, Bay St. Louis, Mississippi;* **New Orleans:** *P.O. Box 29100-MTZ, New Orleans, Louisiana;* **Seattle:** *P.O. Box 3822-MTZ, Seattle, Washington.*

BOEING
AEROSPACE GROUP
MISSILE & INFORMATION SYSTEMS DIVISION
SPACE DIVISION

How to package an F-111 or what have you

PROBLEM: Design and produce an insulation for the F-111 cockpit, to protect instrumentation as well as pilot.
SOLUTION: A special lamination of nylon and white Tedlar was produced by Schjeldahl to provide a combination thermal protection and moisture barrier.

PROBLEM: Design and produce a global horizontal sounding system with 160 mc frequency, capable of 30-day flight, completely frangible to prevent possible damage to aircraft.
SOLUTION: Schjeldahl designed and supplied the entire package, namely a superpressure balloon of Mylar bilaminate, with a suspended pillow containing flexible etched circuitry and micro components for transmitter, receiver, logic, sensing circuits, batteries and solar cells.

PROBLEM: Create a temporary pressure seal for space-simulating chamber for the testing of rocket engines.
SOLUTION: Schjeldahl produced a perfect seal with a diaphragm made of several layers of Mylar, bonded together with Schjel-Bond adhesive. An explosive charge expels the diaphragm just prior to rocket firing.

PROBLEM: Design and produce a lightweight thermal balance shroud for Lunar Orbiter.
SOLUTION: Schjeldahl produced a thin-film laminate with a vacuum-deposited aluminum SiO coating for a specific a/e ratio. The material is exceptionally strong, lightweight, and easily fabricated with special tape to fit any configuration.

PROBLEM: Package 26 million cu. ft. of helium in a bag to support a space platform for a prototype of the Voyager landing module.
SOLUTION: The "bag" is a balloon made of a new Schjeldahl lightweight material .00035 inches thick. It has unique tear-stopping properties and tensile strength of 30 lbs. per inch. The balloon will lift a 1700 lb. payload to 130,000 ft.

If you have a "packaging" problem, be it thermal, electronic, mechanical, protective, gaseous, aqueous, whatever . . . we can very likely solve it for you. Don't let pronunciation stop you. Call *Shell-Doll.*

GT Schjeldahl / ADVANCED PROGRAMS DIVISION

G. T. SCHJELDAHL COMPANY • NORTHFIELD, MINNESOTA 55057 • PHONE 507-645-5633

Circle No. 21 on Subscriber Service Card

single crystals of tungsten to ⅜-in. dia. and tantalum to ½-in. dia., both in lengths up to 3 in., have been produced for researchers. In the electron-beam float zone refining techniques, the materials are processed in a working vacuum of 10^{-6} torr, producing purities of up to 99.999%, including gases.

Circle No. 156 on Subscriber Service Card

Camera Accessories

Accessories designed to broaden the capabilities of the Polaroid CU-5 close-up camera in the fields of industrial and scientific research have been introduced by Polaroid Corp.

Interchangeable camera components include 3-in. and 5-in. lens modules and framing devices that provide reproduction ratios of 1:1, 2:1 and 3:1, four framing kits for additional reproducing ratios, a polarizing filter, and a Y-cord power connection. The framing kits provide added ratios of ¼:1, ⅓:1, ½:1 and ¾:1. All components for a desired ratio or field size are color-coded to permit rapid assembly.

Each framing kit consists of a metal field frame, supplementary close-up lens, metal legs to fix exact focus and an accessory mount that clips onto the camera front. The polarizing filter fits over both camera lens and electronic flash unit to polarize both light reaching the subject and the film. The Y-cord, which connects both to the camera and the a-c power pack of the electronic flash unit, permits using off-camera synchronized flash, by-passing the ringlight.

Circle No. 157 on Subscriber Service Card

Recording Oscillograph

A recording oscillograph that uses an electronic drive permitting the user to specify any of 1,000 chart speeds is being marketed by Century Electronics and Instruments, subsidiary of Century Geophysical Corp.

Model 447 permits the user to change to any 12 speeds at any time and as often as desired. Speeds from 0.1 ips to 100 ips are obtainable.

Automatic record length is based on time, and remote speed control is continuously variable for optimum record analysis. Also featured are remote-control options including start, stop, and chart speed drive.

Circle No. 158 on Subscriber Service Card

Turret Attenuator

A wide-range turret attenuator that covers 0 to 50 db in 1-db steps has been introduced by Texscan Corp.

Model RA-54 is a miniature dual

This IBM recruitment ad is about empty airline hangars.

Yes, empty airline hangars.

Obviously, the less time a plane's in the hangar, the more it's in the air—working.

But what has this to do with your career opportunities at IBM? Simply this:

IBM, in cooperation with Eastern Airlines, is developing a new digital airborne processing and recording system. It's called AIDS—Aircraft Integrated Data System. What's its object?

To alleviate unnecessary on-the-ground checks.

How? By identifying components that *really* need to be fixed or replaced, and *predict* when this will occur.

A prototype IBM AIDS capable of monitoring 300 key airframe, engine and subsystem parameters, as frequently as once a second, is currently operating aboard an Eastern Airlines Whisperjet on regular passenger flights.

Today this data is recorded during flight, then processed and evaluated with ground computers. Tomorrow, on-board computers will process this data in real-time.

New? Revolutionary? Exciting? Yes, all of these. And AIDS is just one example of the dynamic work being done by the Electronics Systems Center of IBM's Federal Systems Division in Owego, New York. What we need now are professionals who can develop and design more new systems like AIDS. Perhaps you.

If you're challenged by the prospect of developing newer and more sophisticated systems and their applications, you could be one of the growing minds we're looking for. See if your discipline is listed. Then write, outlining your experience and education, to: J. R. Raftis, Dept. 604S3, IBM Electronics Systems Center, Owego, New York 13827.
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Systems Analysts • Electrical Engineers experienced in avionics subsystems • Mechanical Engineers—hydraulic systems, control mechanisms, landing gears • Aeronautical Engineers—controls—flight and engine; propulsion—turbo jet engines • Statisticians—data analysis • Operations Research—modeling and simulation for design and management decisions • Airline Economics—analysis of data, equipment and airline operation factors such as maintenance, fuel consumption, reliability and schedules • Aircraft Instrumentation—aircraft equipment installation, FAA design regulations.

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* RELIABILITY
* PRODUCIBILITY
* COST REDUCTION

The Applied Physics Laboratory of The Johns Hopkins University has been given comprehensive new missile systems engineering assignments by the U.S. Navy. These programs, which directly concern the operational reliability, producibility and cost reduction of advanced surface missile systems, have created career openings of exceptional potential for senior engineers with 10 years experience in:

MECHANICAL ENGINEERING
To design, develop and analyze missile structures, instrumentation, launchers, advanced mechanical and hydraulic components and servo-mechanisms. BSME or MSME, knowledge of manufacturing processes and familiarity with servo systems and components.

ELECTRO-MECHANICAL ENGINEERING
To design, develop and analyze packaging and shock and vibration isolation of electronic equipment; coordinate electronic and mechanical interfaces and investigate fabrication techniques. BSME or MSME with electronics minor; missile experience preferable.

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Circle No. 22 on Subscriber Service Card

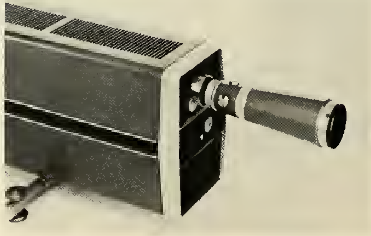
concentric rotary attenuator with dual rotors that are each adjustable independently. One rotor provides 0 to 40 db attenuation in 10-db steps, while the other rotor provides 0 to 10 db in 1-db steps for a total of 50 db. The dial arrangement digitally displays the total attenuation.

The instrument provides an accuracy of better than ±0.5 db at 500 MHz, ±1 db at 1,000 MHz, and ±1.5 db at 1,500 MHz. The VSWR is less than 1.25 and insertion loss is less than 0.3 db at 1,000 MHz.

Circle No. 159 on Subscriber Service Card

Beam-Expanding Telescope

A precision beam expanding telescope with built-in spatial filter for use with gas lasers operating at 632.8 nm is being marketed by Spectra-Physics, Inc.



Model 331 permits expansion of the usual 1 to 2-mm beam size to a 50-mm-dia. collimated beam. Optics are highly corrected, producing a plane-wave output to within 1/10th wave when properly focused. The spatial filter produces spherical wavefronts between F/30 and F/3.6.

Applications include long-distance transmission of laser beams to minimize beam divergence, interferometry, and related uses requiring large-diameter collimated beams.

Circle No. 160 on Subscriber Service Card

Digital Plotter

A digital plotting system that includes a choice of off-line readers and either a vertical or horizontal plotter has been developed by Milgo Electronic Corp.

The DPS-6 system incorporates a plotter with dynamic accuracy of ±0.05% of full scale and is capable of plotting points, lines, curves, or alphanumeric printing on all plots. The system accepts magnetic tapes recorded in either gapped, gapless, or long record format. An optional core storage buffer allows up to 10,800 bits between gaps.

For continuous lines up to 42-in. long, the only programming required is the end points. A second tier subroutine is not necessary.

Circle No. 161 on Subscriber Service Card

Portable Voltmeter

A general-purpose voltmeter with frequency response of 50 kc to 800 mc has been announced by the ITT Industrial Products Div. of International Telephone and Telegraph Corp.

The all-transistor level-measuring set, Type 74832, is a portable 75-ohm-input voltmeter. Housed in a cast metal case, the set combines small size, light weight and long operation from its internal dry cells, the firm says. Three root-mean-square measuring ranges are provided: 0 to 60 and 0 to 600mv, and 0 to 3v. The scale on the 60-mv range is graduated from —10 to 0 db. Response is flat within 0.3 db between 1.0 and 30 megacycles and 0.6 db between 30 and 500 mc.

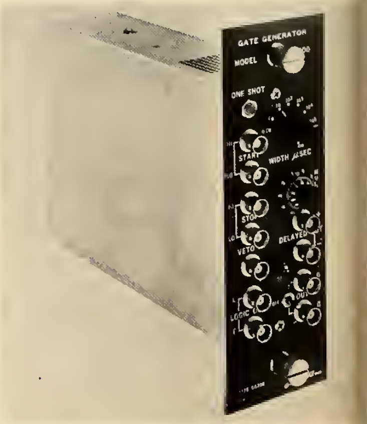
The device will function as a beat-frequency indicator for checking the intermediate frequency on radio links and as a frequency-deviation meter by the disappearing carrier method.

Circle No. 162 on Subscriber Service Card

Gate Generator

A gate generator that provides six outputs, including system logic and gate signals and their complements, has been developed by EG&G, Inc.

Model GG200 features delayed positive and negative trigger signals at the end of each gating cycle, permitting use as a delay generator. Timing is independent of rate, with no dependence between rate and timing. Gating time range is extended down to 100 μsecs and up to 11 secs in eight overlapping ranges. The timing cycle may be started and stopped by ±5v to ±50v pulses as well as logic signals. Output gate and logic signals may be vetoed by logic signals.



All outputs drive 50-ohm loads and are fully protected from overload damage.

Circle No. 163 on Subscriber Service Card

recision Potentiometer

A series of precision a-c potenti-
meters that meet requirements of mili-
ary specifications including MIL-E
05272 and MIL-R 12934 is being
arketed by Perkin-Elmer Corp.

Model 7B1 of the Series 7 Vernistat
otentiometers offers output impedance
f 20 ohms and input impedance of
00K ohms, with absolute linearity of
0.01%. Input voltage at 400 cps is
0v.

The 20-turn unit provides theoretical
esolution, 100/N, of 0.004%, with
aximum output current of 25 ma.

Circle No. 164 on Subscriber Service Card

acuum Oven

A table-top portable vacuum oven
at features pre-positioned stainless
teel shelf tracks which permit with-
rawal of either of the unit's two shelves
ithout danger of accidentally dumping
e work load has been developed by
emperature Engineering Corp.

The Tempcor model 1430 attains
ressures of 1 x 10^{-3} torr and tempera-
ures to 200°C. It provides controllable
akeout and drying of electronic com-
onents and other materials without
anger of contamination by oxidation.
mesh-protected safety window pro-
ides protection against implosions and
ermits visual observation of compo-
ents during processing. Inflammable
ases and explosive gases are thrown
ff automatically.

The vacuum chamber is made of
elded 0.125-in.-thick stainless steel
ith all penetration ports welded into
osition. Glass fiber insulation of the
ork chamber assures low thermal loss.

Circle No. 165 on Subscriber Service Card

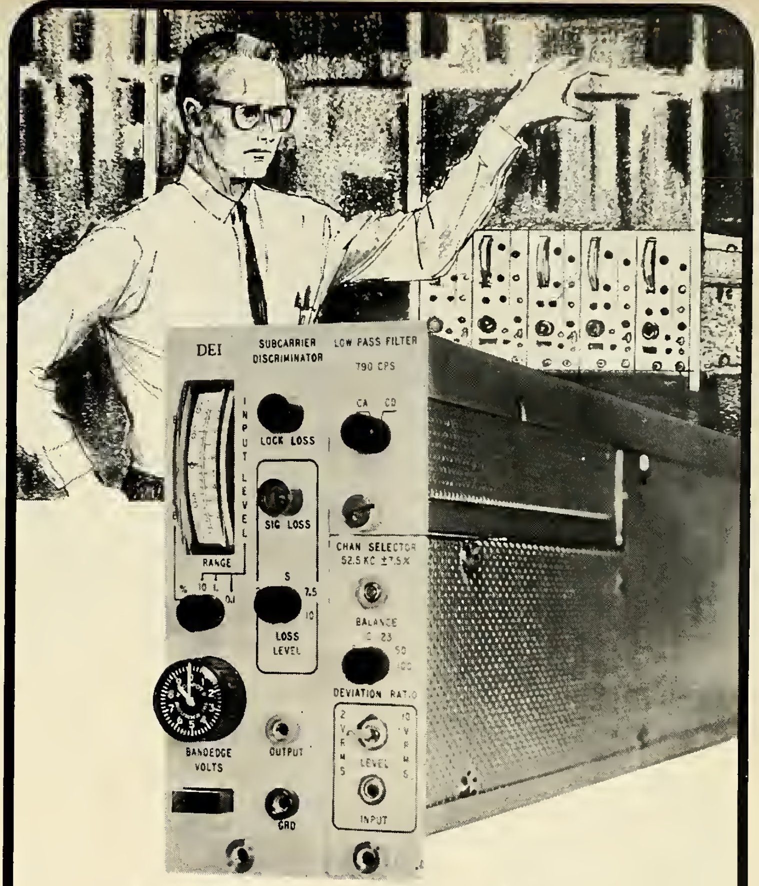
iffusion Pump

A 10-in. high-speed fractionating
iffusion pump for applications requir-
g high speed over a wide range, rapid
ycling and low ultimate pressures has
een developed by High Vacuum
quipment Corp.

The Model FPS-4500 five-stage
ump features a speed of approximately
,300 liters per second and a forepres-
ure tolerance of 650 microns while op-
rating from 10^{-3} torr to well into the
0^{-10} torr range. Ultimate vacuum of the
affled pump is 3 x 10^{-10} torr and,
nbaffled, 3 x 10^{-8} torr.

The instrument has a stainless steel
ody with replaceable cast iron heater
nd quick-cool copper coil. The pre-
ision-spun aluminum jet assembly is
ositioned with a single central hold-
own bolt for simplified removal and
aintenance.

Circle No. 166 on Subscriber Service Card



NEW . . . MODULAR . . .

PHASE-LOCK LOOP DISCRIMINATOR

- **Acquires lock at S/N ratio of −3 db.**
- **±180° phase-lock loop; deviations up to ±40%.**
- **Bandpass phase linearity better than 1%.**
- **Integral power supply: 115/230 v, 47-420 cps.**
- **Minimum input of 2 mv rms.**
- **Isolated input, output and chassis commons.**
- **Front panel threshold adjust for signal loss indication.**
- **High level output: ±1.0 to ±10 volts/100 ma.**

The SCD-1 is designed for telemetry applications in which an FM multiplex signal is to be demodulated by phase-lock detection. All standard IRIG channels are included, along with AIA channels, plus special channels. Channel selectors have adjustable phase-lock loop bandwidths for deviation ratios of 1, 5, 10, 25, 50 and 100.

Working dynamic range for any selected input is 60 db. Input impedance is 100k minimum. Truly isolated input allows selective grounding of input and output. Output filter is of active element type, with either of two response characteristics.

Standard tape speed compensation results in a minimum of 30 db improvement ratios for speed variation of ±3%. The integral power supply has a maximum power requirement of 18 watts.

The design is modular. The size is 2⅞" x 5¼" x 18" maximum. Low pass filter and channel selector are removable, independent units.

Defense Electronics, Inc.

Rockville, Maryland

DEI
RESEARCH
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Names in the News

ROADMAN

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Brig. Gen. Charles H. Roadman: Named commander of the Aerospace Medical Div., Air Force Systems Command, Brooks AFB, Tex. He is currently command surgeon for the Air Defense Command. In 1961, he was assigned director of aerospace medicine at NASA's Manned Spacecraft Center, where he was responsible for planning, programming and implementation of all medical development and medical support for Projects *Mercury, Gemini* and *Apollo* and the manned lunar landing program.

John J. Graham: Appointed a vice president of General Dynamics Corp. He will be concerned with corporate development. He has been a vice president of the Curtiss-Wright Corp. and president and general manager of its Wright Aeronautical Div.

Hugh A. McCloskey: Appointed president of Maxson Electronics Div. of Maxson Electronics Corp. He has been associated with aerospace and electronics companies for more than 21 years.

G. T. Willey: Elected a vice president of the Martin Marietta Corp. He will continue his duties as general manager of the Martin Co. division operations in Orlando, Fla. **J. Donald Rauth** and **Vernon R. Rawlings** were also named as vice presidents and will continue their duties as general managers of the Denver, Colo., operations and Baltimore, Md., operations, respectively. Also, **William B. Bergen,** president of the Martin Co., and **Joseph E. Muckley,** president of the commercial group, were named executive vice presidents.

Dr. John Clark: Named director of NASA's Goddard Space Flight Center. He has been acting director of Goddard since July, 1965. To succeed Clark, **Dr. John E. Naugle** was named deputy associate administrator for space sciences and applications. **Jesse L. Mitchell** was appointed director, physics and astronomy programs of the Office of Space Science and Applications; **Dr. Henry J. Smith** was named deputy director.

A. G. Handschumacher: Elected a director of Allied Research Associates, Inc. He is president and chief executive officer of Aeronca Manufacturing Corp. Prior to joining Aeronca in 1965, he was president of Lear Siegler, Inc.

Dr. Warren E. Snyder: Appointed vic president, engineering and research, fo the American Bosch activities of th American Bosch Arma Corp. He will b responsible for directing the engineering research and product development of th automotive, diesel and electrical products

Dr. W. H. Pickering: Awarded the 196 Spirit of St. Louis Medal. The awar was made for "outstanding service t the United States in directing the research, design development and successful operation of the *Ranger* unmanne lunar reconnaissance spacecraft and th *Mariner* unmanned interplanetary spacecraft." Pickering is head of the Jet Propulsion Laboratory. The award was established in 1929 by Philip D. Ball and th citizens of St. Louis.

Nikolai Nikolaevich Bogolyubov Awarded the 1966 Dannie Heinema prize for mathematical physics. The awar is presented annually by the America Institute of Physics and the America Physical Society. Bogolyubov was cite for the first rigorous proof of dispersio relations for the nonforward scattering o elementary particles. He is director of th Laboratory of Theoretical Physics of th Joint Institute for Nuclear Research Dubna, Russia.

Dr. William V. Wright, Jr.: Appointe director of Environmental Science Services Administration's (ESSA) office of science and engineering. Since 1965, Wrigh has been vice president of Electro-Optica Systems, Inc. The office which he wil head coordinates the new agency's tota research effort.

Dr. George W. Stroke: Appointed consultant to the space optics laboratory o NASA's Electronics Research Center. H is professor of electrical engineering a the University of Michigan and head o the electro-optical sciences laboratory. H will consult with the NASA laboratory o research related to holographic three dimensional information recording an reconstruction processes.

Paul B. Wilson: Elected president o Pickard & Burns Electronics, research an development division of the Gorha Corp. He will continue as a group vic president of Gorham Corp., in which capacity he has responsibility for the corporation's bronze and industrial divisions

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When and Where

MAY

18th National Aerospace Electronics Conference, sponsored by the Institute of Electrical and Electronics Engineers, Sheraton Hotel, Dayton, Ohio, May 16-18.

Fourth National Biomedical Sciences Instrumentation Symposium, sponsored by the Instrument Society of America, Disneyland Hotel, Anaheim, Calif., May 16-18.

International Symposium on Microwave Theory & Techniques, sponsored by the Institute of Electrical and Electronics Engineers, Palo Alto, Calif., May 16-18.

Ninth National Instrument Society of America Power Instrumentation Symposium, Statler Hilton Hotel, Detroit, Mich., May 16-18.

Bureau and Consultative Council Meeting, sponsored by the Intergovernmental Oceanographic Commission, Paris, France, May 16-18.

Colloquium on Selected Topics in Aerothermochemistry, Oslo, Sweden, May 16-20.

Seminar on Satellite Communications Earth Station Technology, sponsored by the State Department Office of Telecommunications, State Department, Washington, D.C., May 16-27.

Sixth National Security Industrial Association/Navy Anti-Submarine Warfare Innerspace Conference, Washington, D.C., May 17-19.

Thermoelectric Specialists Meeting, sponsored by the Institute of Electrical and Electronics Engineers, American Institute of Aeronautics and Astronautics, Department of Interior, Washington, D.C., May 17-19.

Los Angeles National Aviation Show & Aerospace Exhibition, Pan Pacific Auditorium, Los Angeles, May 17-22.

29th National Meeting of the Operations Research Society of America, Miramar Hotel, Santa Monica Calif., May 18-20.

Hydrogen Maser Lecture, sponsored by the Advanced Research Projects Agency, Pentagon, Room 5A 1070, Washington, D.C., May 19.

Society of Plastics Engineers Regional Technology Conference, Statler Hilton Hotel, Hartford, Conn., May 19.

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Yea, Team!

THE DEPT. OF DEFENSE decision supporting team bidding on major defense systems (see p. 10) is one to be applauded. There was no established DOD policy on the subject and recent actions of the Pentagon had left the issue in some doubt.

Acceptance of the integrity of bidding teams is of major importance to subcontractors, who have neither the resources nor the desire to engage in a second competition after prime contractor selection. There is sufficient financial drain and uncertainty in competing for defense contracts without the added worry that one still may be thrown to the wolves even if a member of the winning team.

The open question was increasing the already too heavy financial burden on subcontractors, both large and small, for they were faced not with a win-or-lose situation on which to place their chips but with a maybe-you-do and maybe-you-don't arrangement. Under these ground rules, too close association with a losing prime could bar victory on a subcontract which might still be up for grabs after the prime decision. It was necessary therefore for a subcontractor to maintain liaison with a great number of prime bidders—at added cost. It also engendered a reluctance to commit one's firm too closely to a single team, which in turn could affect the technical competence of all the proposals received by DOD.

Under the best of circumstances, the prime and major subcontractors form a unit which is better than the sum of its parts. Well-acquainted with one another and with the problems of a particular system, they already have a running start toward successful systems development. Breaking up such a closely meshed team may, in fact, leave the Government with a prime contractor less capable of handling the job than some of his unsuccessful competitors.

Breaking apart a bidding team has another undesirable effect. By lengthening the competitive period of the contract definition phase, it stretches an already too-long procedure even further. The present situation in regard to the *Manned Orbiting Laboratory* is a good case in point.

But by far the most deleterious effect was on the subcontractor. The health of this member of the industry—in terms of both finances and other resources—is of major importance. Lockheed, for example, has announced that 62% of the C-5A program will be subcontracted—some $1.2 billion. With subcontractors carrying responsibilities such as this, it is vital that their capabilities not be stretched any thinner than necessary.

Sidney Sternberg, vice president and general manager of Electro-Optical Systems, Inc., explained the problem very well in a recent speech. He said, in regard to the subcontractor:

"The reason that his investment problems loom even larger than those of the prime is that, while his initial investment of time and funds proportionately parallels that of the prime—though his resources are smaller—the risks he takes become far greater, because he has no assurance that even if the prime does win, he will share in the final hardware contract. No matter how fruitful his contributions, how harmonious his relations with the prime along the road of the PDP, he knows that he may be ditched when the prime reaches home, and more than likely through no fault of his or of the prime's."

THIS IS INDEED, as Mr. Sternberg says, double jeopardy. It is unnecessary and undesirable—in almost all cases. Director of Defense Research and Engineering John Foster and Assistant Secretary of Defense Paul Ignatius, in their policy statement in support of team bidding, wisely have left room for the occasional necessary exception. DOD still may direct substitution of a specific team member for a substantive reason such as an unsatisfactory or marginal technical proposal. Thus, the department maintains the option of taking advantage of a breakthrough by a subcontractor who is not a member of the winning team.

There are also other times when re-opening the subcontract competition may have definite advantages. Such may be the case with the *Short-Range Attack Missile (SRAM)* program, in which the initial teaming was not accepted by DOD. The forthcoming "shoot-off" on the pulse motor propulsion concept may do much to advance the state of the art and bring fresh new technology into the project during the contract definition phase, something which all too seldom happens. Delay is always unwelcome but in this case it may be beneficial.

There will almost always be the temptation on major contracts for the military services or Dept. of Defense to break apart the teams and reassemble the pieces to put together what appears the best proposal on each contract level.

But the long-run effect of this would be to reduce the technical competence of all proposals—and quite possibly the number of subcontractors still in business. The benefits of team bidding, therefore, will continue to outweigh the disadvantages in almost all cases.

The DOD policy statement, which is to be written into the Armed Services Procurement Regulations, recognizes this when it states: "The objective of such an arrangement should be to complement the unique capabilities of each team member and to offer to the DOD the optimum combination of capabilities to achieve the desired operational performance, cost and schedule of the system being procured. The formation of such teams shall be at the discretion of potential prime and subcontractors."

This clearing of the air is most welcome to the industry.

William J. Coughlin

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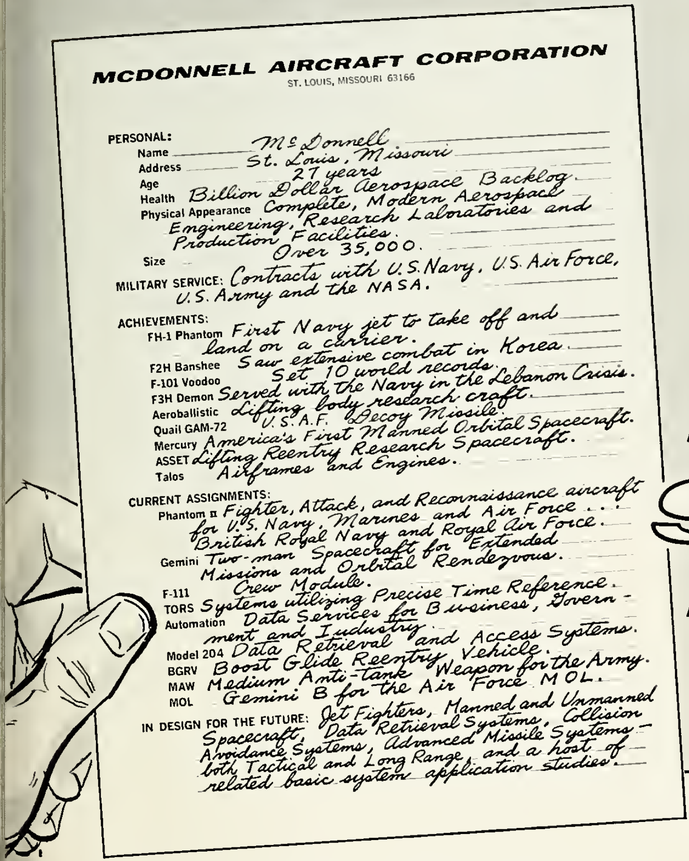

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THE MEETING WAS OUT OF THIS WORLD!

— so was the accomplishment: man's first link-up of two orbiting vehicles in space. Docking of NASA's Gemini 8 spacecraft and Air Force Agena target vehicle, high over the coast of Brazil on March 16, 1966, was a major step in the Project Apollo goal of landing men on the moon in this decade. Making significant contributions to our space effort is becoming routine for Bell's Agena rocket engine. With an unmatched record of 99.5 percent reliability in more than 175 flights and missions, totaling more than 200 starts and restarts in space, the 16,000 pound thrust Agena has orbited more than 80 percent of USAF and NASA satellites. No wonder the Bell Agena engine is called "the workhorse of the space age."

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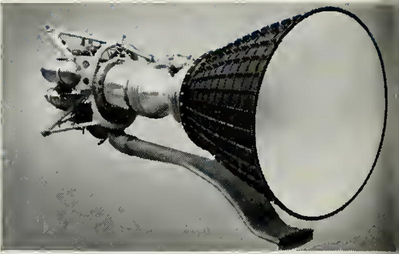
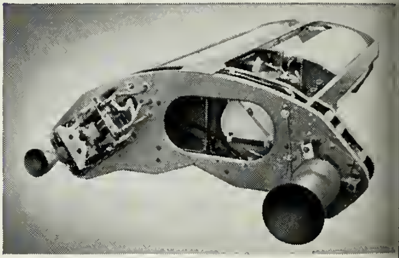
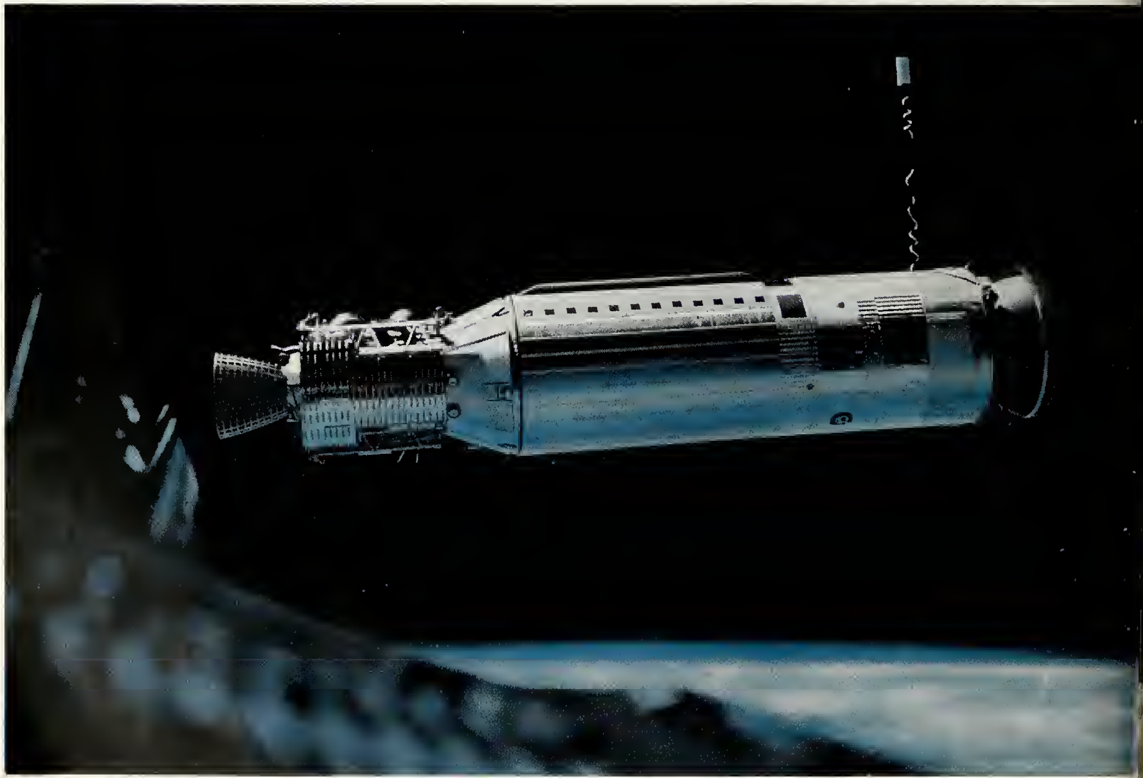


The Bell modified Agena 16,000 pound thrust primary rocket engine placed the target vehicle in orbit and restarted eight times on the rendez-vous mission . . . more than double the number of any comparable engine.



This Bell secondary propulsion system provides ullage control and can make minor adjustments to the orbit of the target vehicle. The ullage engines started in space nine times . . . the large orbit adjust engines started twice during the mis sion. They can be fired up to 150 times.



The rendezvous target vehicle as photographed in orbit by Astronauts Neil Armstrong and David Scott from Gemini 8 shortly before docking 185 miles above the earth. The modified Agena rocket engine appears at the left. (Official NASA photo.)

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MAY 23, 1966

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Can one radar system do the work of two?

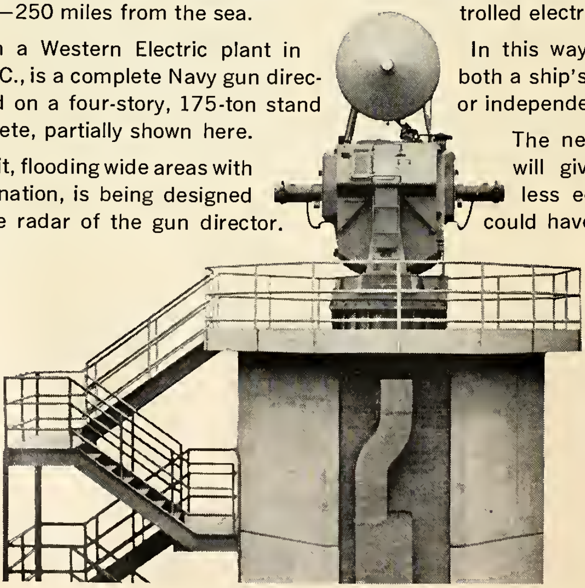
Bell Laboratories and Western Electric, research and manufacturing arms of the Bell System, are helping the Navy find out—250 miles from the sea.

A few steps from a Western Electric plant in Winston-Salem, N.C., is a complete Navy gun director. It is mounted on a four-story, 175-ton stand of brick and concrete, partially shown here.

A special radar unit, flooding wide areas with its invisible illumination, is being designed for addition to the radar of the gun director. This supplemental radar will direct missiles to approaching targets for intercept. The entire operation is controlled electronically from below deck.

In this way, the director will be able to direct both a ship's guns and its missiles simultaneously or independently at a given target.

The new dual system—when it proves in—will give the Navy greater flexibility with less equipment, as well as a system that could have less impact on the taxpayer.



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THE COVER

Westinghouse Deepstar-4000, which exceeded its design depth of 4,000 ft. by 132 ft. in its first attempt to reach that depth May 13. The submarine will be leased to the Navy for submarine-detection research, and geological and biological studies of the ocean floor and the Continental Shelf—all following Navy certification.

49,000 copies this issue

SCIENCE/SCOPE

More than 25 fighting ships of the U.S. Navy will be equipped with improved NTDS (Naval Tactical Data System) consoles during the next three years. The consoles present a real-time picture of aircraft, ships, and submarines within range of a fleet's far-seeking electronic sensors, thus eliminating tedious hand-plotting of target information. This $18.9-million NTDS contract is the third for Hughes, whose equipment already is aboard the nuclear-powered USS Enterprise and USS Long Beach, as well as many other fighting ships.

Prototype of a tank laser rangefinder has been delivered to Bofors Electronics, AB. It's the first product of a joint venture between Hughes and Bofors, Sweden's largest arms maker. New rangefinder will be installed in one of Sweden's new "S" tanks for evaluation by the Royal Swedish Army. Exhaustive field tests will be carried out against snow-covered backgrounds in northern Sweden.

Ship-to-ship communication between Atlantic and Pacific will be possible for the first time with the new shipboard communications sets being delivered to the U.S. Navy. New sets will beam their messages to a satellite in space, which will retransmit them to antennas thousands of miles away. Their microwave line-of-sight transmission is unaffected by natural disturbances that may disrupt conventional high-frequency transmission. Hughes has developed a lightweight three-axis pedestal that keeps the antenna stable in heavy seas. These shipboard satellite communications sets will make possible a global network using only three or four synchronous satellites placed strategically around the globe.

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First powered flight test of the U.S. Navy's newest missile, the Phoenix, was conducted successfully at the Pacific Missile Range on April 27. The operation took place near San Nicolas Island, 50 miles off the California coast. It proved the compatibility of the missile and the test aircraft, and paved the way for the next step in the development of the Phoenix. The Phoenix will be the primary air-to-air weapon of the F-111B, Navy version of the multi-service jet fighter.

Can laser techniques give low-flying jets an improved terrain-clearance capability? Hughes laser specialists are seeking the answer under a new study contract with the U.S. Air Force. Of particular interest to USAF is the possibility that a laser radar system may be more reliable than existing systems -- and easier to maintain.

A study is now underway to develop a compact command-and-control system (407-L) for the U.S. Air Force. Hughes has been awarded a $1-million contract to examine the operational requirements of the proposed tactical air operations center, which will be transportable by helicopter.

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The Countdown

WASHINGTON

Standard Seen as All-Purpose Missile

General Dynamics, manufacturer of the multi-service F-111 aircraft, may have another multi-purpose weapon system on its hands. The GD/Navy *Standard* missile, soon to go into production as the next-generation shipboard air-defense missile (M/R, May 16, p. 9), is also being considered for air-launch as a long-range interim anti-radiation missile. Pentagon sources say Navy and Air Force have recommended a parallel development effort for the *Standard* missile and the Hughes/Air Force *AIM-47A* (M/R, Mar. 21, p. 8). Out of this phase, possibly lasting six months, would come a single interim-*ARM* to serve as a *Shrike* follow-on. This weapon would go into service before the new *ARM-1* missile is developed. Dept. of Defense reaction is said to be favorable. Request for proposals on *ARM-1* (M/R, Oct. 18, p. 21; Jan. 31, p. 17) is also believed to be imminent.

Redeye Shipboard Tests To Start

First firings of the Army-developed *Redeye* shoulder-fired air-defense missile from a shipboard platform (M/R, May 9, p. 7) are expected to begin this week. Navy tests of the missile are expected to last several months.

Congressional Probes Are Upcoming

The Senate Commerce Committee communications subcommittee is expected to hold hearings on the national communications satellite program as soon as a report on the subject is made public by the President's Telecommunications Office. The House Armed Services special investigations subcommittee is ready to convene when preparatory staff work is completed on the contract award for the Light Observation Helicopter (LOH) and on the Dept. of Defense cost-reduction program.

Eniwetok Range Is Upgraded

Range instrumentation for ballistic missile tests is being expanded in the Eniwetok lagoon target area. Air Force officials say this will give the area basically the same capability for test evaluation that exists in the launch complex. The improvement will allow more extensive target area data on all-weather launchings, on missiles fired on a no-notice basis and on salvo or ripple firings.

Work Proceeding on Eglin Space Radar

Air Force expects the rebuilt spacetrack radar at Eglin AFB, Fla., to be fully operational by Jan. 1, 1968. This is a slippage of only six months from the original schedule which was set before a fire in January, 1965, totally destroyed the huge phased-array system. Preliminary subsystems tests are to begin this fall, with final systems testing expected to start in July of next year. Post-fire decision to rebuild the radar from the outset in its most high-performance configuration, rather than in phases building up to that level, is credited with saving considerable time in getting the unit on the air and into the SPADATS network.

High Polaris Readiness Is Disclosed

Analysis of *Polaris* missile and fire control performance by Navy submarine crews on patrol shows that all 16 missiles aboard each sub are ready to fire 98.1% of the time. When overall reliability and on-target accuracy is included, Navy officers say, at least 14 of the 16 can be expected to deliver their payloads on target.

INDUSTRY

GD Has Edge on Standard Production

Although the Navy will hold a production competition for the *Standard* missile in its primary air-defense role (M/R, May 16, p. 9), sources close to the program believe General Dynamics/Pomona, now serving as the missile-design and pilot-production agency for the Navy, will be hard to beat. GD's cost proposals for a quantity buy are certain to be favorably affected by the firm's pilot production run, which could amount to some 700 missiles. Follow-on buy may exceed 3,000.

Raytheon Asked for Tartar-D Quote

Raytheon Co., builder of the off-mounted AN/SPG 51-D radar portion of the Tartar-D fire-control system, has been asked for quotes by the Navy on undertaking the systems management role of the complete Tartar-D fire-control system.

INTERNATIONAL

Soviet Sea-Based Missile Discounted

Dept. of Defense and Navy sources don't place much credence in last week's reports from unidentified "diplomatic sources" that the Soviets have developed a fixed-base undersea missile which can be planted close to U.S. shores and fired remotely.

French Study Mach 5 Ramjet

Four experimental ramjet missiles launched by the French Office National d'Etudes et de Recherches Aerospatiales (ONERA) reached speeds of nearly 4,600 fps between altitudes of 40,000 and 115,000 ft. The four were part of a 10-flight program code named STATALTEX which has generated data applicable to eventual development of an atmospheric booster able to reach Mach 5.

Soviets Take Photo of Earth

The Soviet news agency TASS reports that a Russian communications satellite has taken the first TV photos of the Earth from space and successfully transmitted them back to ground stations. TASS says the pictures were taken by *Molniya I* in orbit at altitudes ranging from 18,600 to 24,800 miles.

Italy Cancels U.S. Buy

Italy's new Secretary of Defense, Roberto Tremelloni, has vetoed an agreement made last year between his predecessor and U.S. Defense Secretary Robert McNamara on the purchase in the U.S. of 500 M60A/1 armored cars for $136 million. He also has stopped preparations for production under license of 165 F-104S fighters until flight test of the prototype. The F-104S is to carry the *Sparrow* missile.

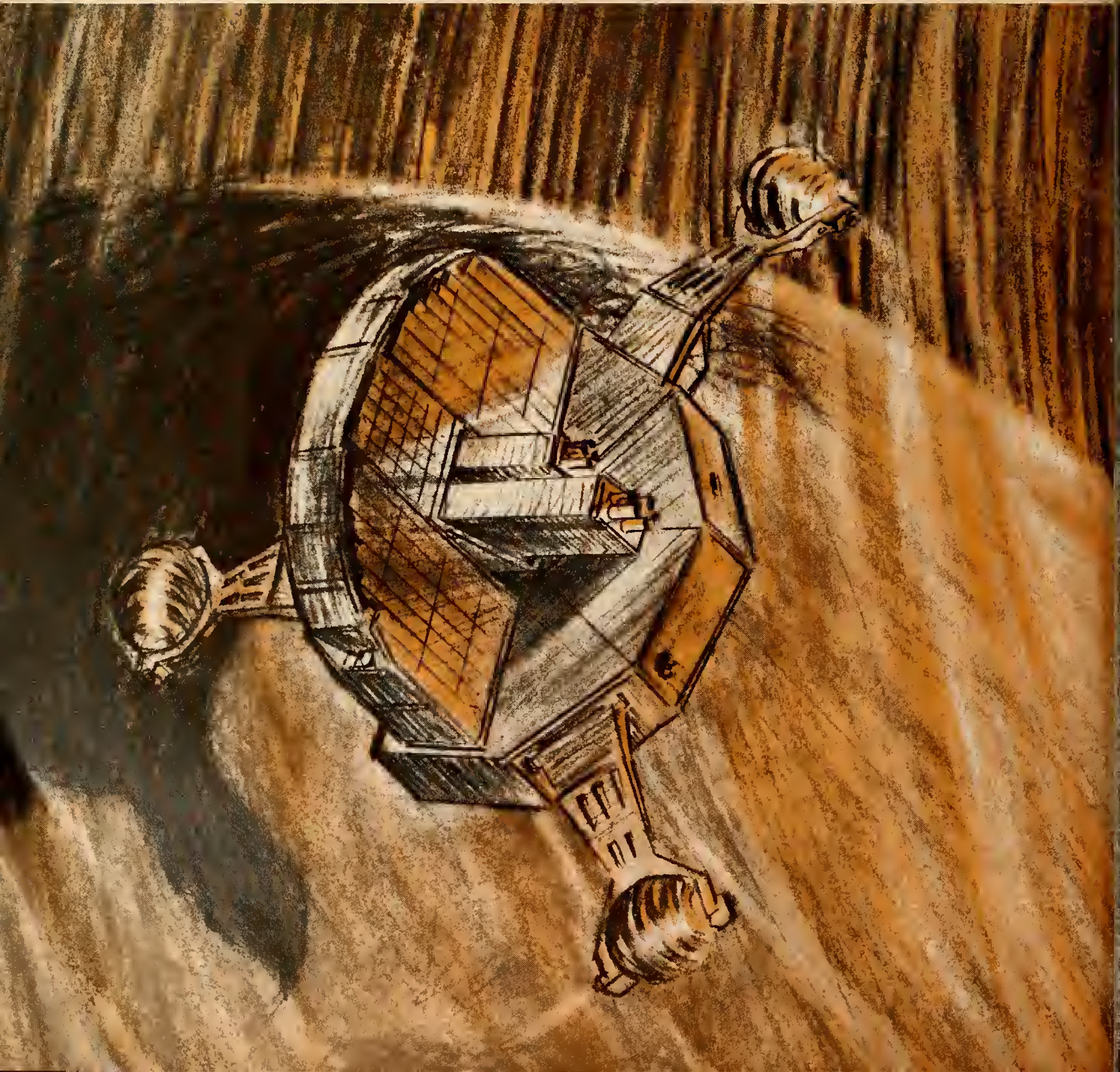
Speaking of sunshine, EMR *telemetry does...*

Telemetry equipment built by EMR was a vital part of the single information link from the Orbiting Solar Observatory (OSO-II) during its active lifetime.

Built by Ball Brothers Research Corporation for NASA's Goddard Space Flight Center, OSO provided a platform outside the earth's atmosphere for intensive study of the sun.

To transmit data from OSO-II's 8 experiments, EMR designed and built a 122-channel PCM system which operates on only 1.2 watts. Performance records show that not a single data channel was lost from the time OSO-II went into orbit February 3, 1965 until it was intentionally shut down more than nine months later.

The extensive experience gained on such systems as OSO has already been put to use in building the telemetry equipment of the future . . .



House Raps DOD Again

A House Armed Services Committee report released last week on the Fiscal 1967 budget authorization is the longest and most comprehensive ever issued by the committee. It is also the most vituperative.

Armed with what Congressional committeemen feel is the most ammunition they have ever had with which to attack Pentagon management, the report forecasts the strongest fight ever to be made by Congress over its rights *vis-à-vis* military decision-making.

The report also contains the most direct verbal assault upon Secretary of Defense Robert S. McNamara made by the full committee since the Secretary came to office.

The House committee added $931 million to the FY '67 DOD budget request, bringing total DOD authorization for weapons procurement and R&D to $17.9 billion (M/R, May 9, p. 14).

Among the livelier quotes from the report:

". . . too often, it is feared, the almost obsessional dedication to cost-effectiveness raises the specter of a decision-maker who, as it has been said, knows the price of everything and the value of nothing."

". . . on the civilian side in the Pentagon there can be no doubt that there is much brilliance. But the committee is quite willing to question whether this brilliance is reflected in the direction of our military planning. There can be no greater weakness in men in positions of public responsibility than that they be incapable of reflection or self-examination."

". . . again this year, the committee must alert the House to the fact that power in the past has moved—on tiptoes—from Capitol Hill to the Pentagon, and once there, has reached back a friendly hand and issued a smiling invitation to come on over and watch the computer work. The committee intends to play the tune to which the legitimate power of the Congress will march back up Capitol Hill.

". . . on occasion, channels of communication for public, unclassified information of particular importance are blocked by action within DOD. Documents are stamped 'Secret' which in the opinion of the committee do not contain material that is of a classified nature. It is quite evident that this action is taken in these instances by DOD for the sole purpose of protecting decisions already arrived at and preventing open and free discussion and debate as to whether the decisions are sound."

After rapping McNamara around for several pages, the report then takes some of it back: "In fairness," the report concludes, "the committee must say that it does not think this situation (of intransigence at the top of DOD) has come to pass in any overall and general fashion. . . . That it has happened in some instances is incontrovertible."

Intense Solar Flares Predicted

In a joint announcement to the Seventh International Space Science Symposium of the Committee on Space Research (COSPAR) in Vienna, two American scientists stated that the biggest solar flare in a century should occur about 1969.

R. W. Kreplin and Herbert Friedman of the Naval Research Laboratory based their conclusions on evidence from the solar X-ray monitoring satellite *Explorer 30.* The scientists said the next solar maximum will equal and probably exceed the activity of the 1957-58 period, providing obvious hazards to lunar astronauts.

At the present time, two years after the 1964 minimum, intensity of the 11-year solar activity cycle has already reached 50% of the 1957-58 maximum level. The scientists predicted that with three years remaining to reach maximum levels, the previous maximum intensity would be exceeded.

Westinghouse Gets Sprint Pact

Westinghouse Electric Corp. will design and build three prototype transporter-loader vehicles for the Army's *Sprint* anti-ballistic missile. Work will be done under a $1,477,115 contract from the Martin Co.

Shots of the Week

The *Agena* target vehicle for the *Gemini 9* mission along with its *Atlas* booster fell into the Atlantic Ocean shortly after launch from Cape Kennedy on May 17 (see p. 17).

- NASA's *Nimbus 2* weather satellite was successfully launched May 15 aboard a *Thor-Agena* booster from Point Arguello, Calif. The 912-lb. spacecraft was placed in a 108-min. orbit with an apogee of 732 statute mi. and a perigee of 681 statute mi.
- A *Minuteman I* ICBM with a solid-propellant rocket motor more than four years old was successfully fired from Vandenberg AFB, Calif., May 16. It was the oldest *Minuteman* second stage ever launched. Additional tests are

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planned to study the storage life of the second-stage motor, developed by Aerojet-General Corp.

- The Navy successfully fired the first guided *Phoenix* air-to-air missile May 12 from a A3A Skywarrior over the Pacific Missile Range. The missile scored a direct hit on a target drone.
- Britain's *Skylark* sounding rocket was successfully fired May 5 from Woomera, Australia.
- NASA launched a sounding rocket from Wallops Island, Va., May 18 to measure the brightness of stars.
- The space agency also launched a series of 18 meteorological sounding rockets from Wallops Island, Va., from May 10-13.

GaAs Grown In Vapor

Radio Corp. of America Laboratories has unveiled a new technique for producing semiconductor devices from gallium arsenide (GaAs) and its alloys.

Called vapor phase growth, the technique is analogous to the natural process that produces frost on window panes. All materials used in building a device are prepared separately in a gaseous form. The gases are then mixed in varying, easily regulated proportions and allowed to flow over a solid crystal of GaAs or one of its alloys.

Since the crystal is kept slightly cooler than the gas mixture, the gases begin to condense on its surface in such a way that their atoms form an extension of the crystal structure itself. Thus, the electronic device grown on the foundation crystal is identical to it in every respect except for the desired pn junctions and impurities it incorporates.

Cosmos 110 Reports Given

Soviet doctors observed an increase in the percentage of calcium in the blood and urine of space dogs Ugolek and Veterok the first day after their 22-day flight in February in *Cosmos 110.*

According to a group of scientists including Dr. Boris Yegorov, the cosmonaut physician who appears to be the main investigator for the experiment, X-rays of the dogs' skeletal systems also indicated that calcium had been "washed out." Muscle mass also was changed, although no figures were put to any of these reports.

The dogs had difficulty in resuming normal motor activity and were not fully adjusted until eight or ten days after their return.

The dehydration which appears to be a function of the weightless state again was noted in the animals, which were fed programmed amounts of food and water through stomach tubes.

High pulse rates observed after the flight, another finding common with both Soviet and U.S. manned experience, did not level off until the fourth or fifth day after their return.

The doctors also said that on the fourth to fifth day of their stay on Earth, there was a "rather considerable speedup" of the erythrocyte sedimentation reaction and an increase in the number of leucocytes in the blood, both apparently in response to normal gravity.

Microbiological and immobiological investigations to a certain extent confirm this, they said, although the mechanism of these phenomena is not explained.

In summary, the Soviets said that while functional changes did occur during the flight, there were no irreversible effects. Whether or not zero gravity can change the functional state of the organism to such an extent that it will not be able to return to normal has not yet been answered.

NASA Money Bill Hits Snag

Outcome of a House-Senate conference on the Fiscal Year 1967 NASA authorization bill is uncertain at this point. Both sides have expressed an intention to stick by differences in their respective versions of the bill.

In reporting out the bill, the Senate Space Committee vetoed the House recommendation that the Venus *Mariner* 1967 fly-by mission be cancelled and the money put toward a landing probe to be included on the 1969 Mars *Mariner.*

Neither did the committee approve reprogramming of funds with the Office of Space Sciences and Applications to give the *Voyager* program an extra $22 million to get started on major problem areas faced by the program.

The Senate committee also cut back the 260-in. solid rocket motor program to $3.5 million and trimmed the request for a lunar sample receiving laboratory. The House committee added funds to the solid rocket program and granted the full Administration request for the lunar sample receiving laboratory.

The Senate bill totals $5.008 billion, $4 million below the NASA request. The House recommended $4.986 billion. Other differences in the bill included a cut of $14.6 million for administrative operations.

Thiokol Fires 156-in. Stage

A 156-in.-dia. glass-reinforced plastic-cased, submerged-nozzle solid motor reached full thrust of 300,000 lbs. in a static firing at Thiokol Chemical Corp.'s Wasatch Div. May 13.

The Rohr Corp. nozzle had an expansion ratio of 34:1 and directed the exhaust into an 83-ft.-long diffuser tube to simulate high-altitude atmospheric conditions. The entire motor case was filament wound using U.S. Polymeric's Poly-Preg E-717 preimpregnated roving.

The motor is one of two units being built by Thiokol under contract to the Air Force Systems Command's Space Systems Div. designed to demonstrate feasibility of a high-mass-fraction, high-performance, upper-stage 156-in. solid motor. It is part of the current Air Force large solid technology program.

Saudi Hawk Pact Detailed

Raytheon Co.'s package deal for a *Hawk* air defense missile system with Saudi Arabia (M/R, Dec. 20, p. 9) will total $126 million and will cover a five-year program, the company has announced.

A substantial portion of the actual hardware delivery and site construction will be completed within the first two years. However, training and maintenance provisos will continue for three more years.

Raytheon will also set up and manage an air defense school for training the Saudi Arabians.

Hughes Sets Up SAM Group

Hughes Aircraft Co. has established a new SAM-D Div. at Fullerton, Calif., to handle the company's effort directed at winning the Army's lucrative surface-to-air missile program expected to go into contract definition phase later this summer.

Hughes is teamed with Douglas Aircraft Co. and FMC Corp. in the SAM-D competition. Nine other team or single company entries are also competing (M/R, May 2, p. 7). Hughes and Radio Corp. of America have both held Army contracts for the SAM-D component verification phase.

At least two contractors are expected to be named to move into CDP. Should Hughes not be one of these, the company says, the division will remain and work on new weapon system projects but, of course, under a different name.

New Chaparral Radar Planned

The Army has ordered development of a new forward area alerting radar (FAAR) to operate with the *Chaparral* missile/Vulcan 20-mm gun battlefield air defense system.

The radar will be built by Sanders Associates, Inc., under a $2,983,564 fixed-price contract which covers design, development and fabrication of initial units.

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These are only a few examples of the many challenging and rewarding career opportunities waiting for you at AC Electronics. If you are already experienced in this field, or would like to get into guidance/navigation and control, check the job openings below for all three AC Electronics locations—Boston, Los Angeles and Milwaukee. Then let's talk. Write: Mr. R. W. Schroeder, Dir. of Scientific & Professional Employment, Dept. #5753-M5, AC Electronics Division, Milwaukee, Wis. 53201. Minimum of B.S. degree required.

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Soviet View of Lunar Surface Reported

by William S. Beller

VIENNA—Erosion processes operating on the lunar surface are etching out small linear veins of hard strata and little pedestals of lunar material capped by tiny stones.

The ground is "cellular in honeycomb form" and there is no dust. The lunar landscape is pockmarked with craters down to the finest resolution of television pictures. Many of the smaller craters, with diameters measured in centimeters, have the shape of "old gramophone horns," seemingly formed by the explosion of subsurface charges. Some of the craters have steep slopes, a few measured at 55 degrees.

This is the remarkable new picture that A. I. Lebedinski, professor of physics at the University of Moscow, drew of the lunar surface for Committee on Space Research (COSPAR) delegates here for the closing sessions of the May 10-19 Seventh International Space Science symposium. His findings were based on data from *Luna 9*, the Soviet spacecraft that soft-landed on the Moon on Jan. 31, 1966.

The spacecraft landed near the top of a 15-meter-dia. crater which itself appeared to be inside a larger crater of undetermined diameter. The angle of inclination of the spacecraft was initially 16 degrees—a planned attitude to enable the television camera on top of the station to get panoramic scans of near, as well as distant, ground. Resolution of some of the near objects was said to be of the order of one to two millimeters, framed within three minutes of arc.

A system of direct and mirror views of the same object gave stereo information about the object and permitted its distance from the spacecraft to be calculated. A stroke of good fortune further aided the Soviet scientists. During the 48 hours the television was operating, the lunar station shifted its inclination until it was leaning over 22½ degrees instead of the original 16. This moved the television camera over nine centimeters, a dimension learned from earlier stereoscopic data. Now, with the additional stereo view, the Soviet scientists were able to derive the distances to a great number of objects on the lunar landscape.

Linear structure—Lebedinski said that finding a linear structure of geological character on the Moon was totally unexpected to himself and, he assumes, to many other scientists as well. The lines he saw, which were also seen on the slides he projected for the COSPAR delegates, were described as 20-30 centimeters in length. They were seen very clearly—so clearly, in fact, that an observer might subjectively connect them and get lengths several meters in extent, Lebedinski pointed out.

He said analysis of the 21 most clearly defined lines showed they fell into two primary directions, another indication of geological action. He showed instances where lines crossed craters, thereby dividing the craters.

Negative mass balance—"We counted about 150 clearly defined stones over a 50-sq.-meter area," said the Russian scientist. "Some are one centimeter in diameter, others even smaller." He described these stones "as resting or standing on pedestals not immersed in dust, as one might expect." This condition was true of many stones but not of all that he saw.

Lebedinski said he calls these objects "stones" only conditionally, because he is not sure what they are

He strived to explain the reason some of the stones were mounted on pedestals by surmising that the stones were made of a material stronger than surrounding material, thereby shielding the pedestal material from the eroding action of the solar wind and meteoritic impacts.

He concluded that a "negative mass balance" situation exists on the Moon. Mass is disappearing. It may have been thrown out of the *Luna 9* crater by the erosion of meteoritic impacts and deposited elsewhere on the lunar surface, or the solar wind may be continuously subtracting lunar mass.

"But there is no dust," he stressed. "We could not find any." Lebedinski said that the *Luna 9* findings "indicate a third direction of the Moon's formation." Confessing ignorance as to what it is, he suggested that "a long erosion process is probably still going on."

He agreed that this third direction does not contradict either the meteoritic or volcanic theory of the formation of lunar features.

This new description of the Moon is contained in a book recently published in Russian by the Soviet Academy of Sciences—but so far released only in a very limited quantity.

Kudos—Commenting on the Russian presentation of the *Luna 9* information at COSPAR, Dr. Gerard P. Kuiper of the University of Arizona, a leading U.S. lunar expert, commended Lebedinski for "showing for the first time the open structure of the Moon."

Kuiper said the Russian report was "truly marvelous" and the photographs "complement and supplement the *Ranger* pictures," which he assisted in analyzing.

Dr. Fred L. Whipple, director of the Smithsonian Astrophysical Observatory, added his congratulations and voiced his conviction—not shared by all U.S. scientists present—that the Moon was indeed losing mass.

Earth data refined—In another COSPAR session, it was reported that the shape of the Earth with respect to its center is now known within ten meters. This is an improvement in accuracy by a factor of 50 compared with pre-satellite notions of the Earth's shape.

Hailed as a "milestone in geodetic research" by Jean Kovalevsky of France, chairman of the session here at which the research was described, the work in effect establishes a highly accurate "standard Earth." It also shows "close agreement" between Space-Age and classical methods for determining the Earth's gravitational field, he observed. Moreover, "the satellite geodesy method permits (us) to extend these results to the whole surface of the Earth."

The effort that went into deriving the new figure of the Earth was described by five scientists—F. L. Whipple, E. M. Gaposhikin, W. Koehnlein and W. E. Strange for the U.S., and G. Veis from Greece. About 40,000 photographs taken of 13 satellites over the past seven years went into the geodetic results. The gravitational field problem alone involved solving 80,000 simultaneous equations in 100 unknowns, according to the experimenters.

The photographs were taken by 12 Baker-Nunn cameras of the Smithsonian Astrophysical Observatory, located at stations scattered throughout the world. The work was sponsored by NASA and the various participating countries.

Whipple said that radio tracking data will next be used with photographic data to further improve the accuracy of the geodetic measurements. He said there probably will be no more observations of a solely photographic nature aimed at determining station coordinates or equation coefficients. He predicted that a laser system for ranging on satellites will increase accuracy—possibly to within one meter—in the description of the shape of the Earth.

Laser system—An experimental laser system for determining satellite orbits is already operating. C. G. Lehr of Smithsonian Astrophysical Observatory told COSPAR delegates that more than two hundred range measurements have been made on *Explorers XXII, XXVII*, and *XXIX*, at slant ranges out to about 2,000 mi.

He said the range accuracy was about 1.5-4 meters. With equipment already available, he says, the error should be reduced below one meter.

The present laser system, designed and built by General Electric Co., is installed at the Smithsonian's Organ Pass, N.M., field station. The observers acquire the satellite by cranking in predicted values of azimuth and elevation determined through the photographic tracking system already in operation. Tracking continues visually. Microsecond laser pulses of about eight million watts and one microradian angle are fired at the satellite and returned by corner reflectors. The receiver is a modified searchlight 1.5 meters in diameter. The time the laser pulse takes for its round-trip determines the satellite's range.

The advantage of the laser over the Baker-Nunn camera system is in this range data. On the other hand, the camera system is most effective in finding angular coordinates of a satellite. "The laser can also extend the usefulness of the camera by providing illumination for photography against a star background when the satellite is in the Earth's shadow," said Lehr. He wrote the paper jointly with L. A. Maestre and P. H. Anderson of the Smithsonian staff.

First French results—The first results from the French satellite *FR-1* showed experimentally that very-low-frequency waves are propagated not only along lines of sight but also along the magnetosphere as though in a wave guide. This characteristic of VLF has been known for some time but the *FR-1* made the first direct measurement.

Describing the work, L. R. O. Storey, British scientists working for the French space research agency (CNES-CNET), said the object of the satellite program was to measure the electromagnetic wavefields produced in the lower magnetosphere by ground VLF transmitters.

In a dramatic description of the experiment, Storey told of the *FR-1* passing through the magnetosphere over France and picking up the appropriate VLF pulses. A half hour later, the *FR-1* passed through the magnetosphere again and once more received the pulses. These data were analyzed only a few days before the current COSPAR meetings convened here. ■

DOD Emphasis on Concept Stage To Benefit Industry

by Michael Getler

WASHINGTON—Concept formulation, a 10-month-old official Defense Dept. term that has only recently achieved notoriety, holds the promise of expanded industry participation in the early stages of DOD weapon system planning.

While concept formulation (CF), in theory at least, has been practiced with varying degrees of enthusiasm for many years in DOD, it is only since last July that DOD directive 3200.9 firmly established this practice as the first of three basic steps towards evolution of major new weapons systems.

If successfully arrived at, CF is followed by the contract definition phase (CDP) and then by full engineering development, if the CDP indicates that such development is practical.

The July directive, in effect, replaced the previously used project definition phase (PDP) with the CDP, and substituted concept formulation as a more definitive first step in lieu of some of the less formal activities that had been carried on under pre-PDP billing.

The directive was clearly an attempt by DOD to further strengthen the decision-making process all along the line, and concept formulation specifically was aimed at providing the sound basis.

In effect, some system considerations that may have been encountered for the first time in the PDP of earlier times were moved back into concept formulation. This tended to increase the importance of the pre-definition phase work and conversely added to the significance of a project's moving ahead into CDP.

Industry participation—Because of the new emphasis on concept formulation and its added importance, defense officials told MISSILES AND ROCKETS that closer ties between the DOD and industry on a very broad basis will probably be sought.

This will mean, among other things, bringing industry into a program much earlier, in many cases, than is now done—and on a funded basis.

Up until now, officials report, "industry has been keeping abreast of things too often on the basis of in-house funding spurred by marketing men with a good source of intelligence. We'd like to get industry into some of these programs earlier by bringing them in. There have been instances of this, but we'd like to be more consistent about it."

In some cases, these officials state, by bringing companies in very early in the CF stage, "even while we are just trying to define the problem we face," for example, "the availability of new technology within a firm could perhaps lend an entirely new slant to a project."

Essentially, the CF stage deals with the analysis and definition of the problem and mission confronting DOD; the mission parameters presented in terms of the problem, not the solution; studies of alternate and competing solutions; and thorough trade-off analysis.

With these basic prerequisites satisfied, a project that looks viable in CF will then move into CDP, which actually is the first phase of engineering development—a phase in which roughly 5% of the total engineering effort expected to be associated with any one development effort is normally expended to further define the project in terms of hard engineering specifications and cost data.

AMSA dramatizes CF—The current flap that has focused new attention on the CF, CDP, development sequence concerns the development (M/R, May 2, p.13) of a new Advanced Manned Strategic Aircraft (AMSA)—specifically, the alleged confusion on the part of the Joint Chiefs of Staff (JCS) regarding the implication on full-scale development of a decision to move into CDP.

The celebrated, and rather incredible, spectacle of the JCS not understanding how major weapons systems proceed through DOD's development stages may do more to hasten understanding of that process in and out of the Pentagon than a string of DOD directives and memoranda.

Secretary of Defense Robert S. McNamara, discussing PDP and CDP evolution last week at a press conference, admitted that, "frankly, I'm afraid these concepts aren't clear in the Department today." Other DOD officials told M/R that it takes as much as four years in some cases before a new directive is fully understood within DOD.

In the case of the JCS and the AMSA, the Secretary said the Joint Chiefs' belief that proceeding with contract definition required a decision at that time on full development arose out of a misunderstanding of the relationship between these two phases of the engineering program. "We definitely want to separate contract definition from decisions relating to full development," he said. "The Chiefs didn't understand that, and in some of their initial thinking on the 1968 Joint Strategic Operation Plan (JSOP), were confused by it."

McNamara, clearly defending the capabilities of the JCS, laid the blame largely on a "badly drafted DOD memorandum" and said the "misunderstanding has now been clarified and as a result the JCS are now reconsidering the matter and are free to adopt the position they initially preferred."

The JCS understood, incorrectly, according to the Secretary, "that (AMSA) expenditures for CDP in FY '68 would not be approved unless they were prepared to recommend full development. Therefore they felt compelled to recommend full development."

The memorandum that allegedly caused the misunderstanding is classified and has not been released. However, it is believed to have emanated from within the office of the Secretary of Defense last September and was written in response to an Air Force request to move into CDP on the AMSA program.

DOD directive 3200.9 is specific in outlining the actions that can be taken after completion of CDP. Of five alternatives, only two provide for moving into full engineering development. The project can also be sent back to exploratory or advanced development, continued further in CDP, or abandoned. This clearly supports the Secretary's contention, at least on paper, that CDP does not necessarily indicate development is to follow. At his May 12 press conference, the Secretary stressed that movement into CDP does not indicate even a tentative commitment to full development.

Precedence, however, and the opinion of other DOD officials, tend to compound whatever confusion may have been created by the poorly worded memo.

CDP implications—For example, other DOD officials, while backing up the Secretary, admit that the movement of a project into CDP connotes "a high probability of development." Service project officers often respond to queries regarding the significance of CDP with words to the effect that: "If we weren't intent on going ahead we wouldn't be going through this exercise."

Perhaps most significant is the fact that since PDP, and then CDP, were initiated in the early days of Secretary McNamara's regime at the Pentagon, virtually every project that went into definition phase contracting has moved into full development, according to DOD officials. The one notable exception was the ill-fated *Mobile Medium Range Ballistic Missile (MMRBM);* however, officials say that project never should have got that far and pre-PDP work was not up to standards.

The added emphasis on concept formulation since July will now make it even more likely that CDP means development is almost assured, in the opinion of some officials.

There is much that is confusing about the current hassle over the AMSA. The DOD, and congressional critics of DOD decisions, are both probably guilty of taking supporting statements made during recent budget hearings out of context. Introduction of Fiscal Year 1968 plans on top of the FY '67 budget request, while illuminating the Chiefs' position on the need for a new bomber, tended to confuse the issue of how to go about getting it. The point was apparently further obscured by a misunderstanding within DOD of development phase relationships which was passed on to JCS.

Two points do, however, emerge clearly. One is that the JCS strongly favor a follow-on manned bomber beyond the B-52G and H, and the FB-111. The former, they say, cannot be assured of operational life beyond FY '75, and the FB-111, as presently conceived, cannot reach the more distant targets in China and Russia. The JCS has urged that concept formulation on the bomber be completed as soon as possible.

Dr. Harold Brown, Air Force Secretary, and DDR&E Director Dr. John S. Foster, Jr., both supporters of a follow-on program but defenders of the need for more concept formulation to determine what kind of bomber is needed for what role, indicate this work may be completed this summer or fall.

The other point to emerge from the DOD-service-Congress confrontation is the fact that the highest-level military officers in the U.S., working continuously at defense and within the purview of the Secretary of Defense, can apparently be sidetracked on highly important defense issues by confusion either generated or perpetuated within DOD. ■

NASA Experts To Help Manage MOL

HOUSTON—Top-ranking NASA officials will be assigned temporarily to the Defense Dept. to aid the Air Force in technical management of its *Manned Orbiting Laboratory (MOL)* program.

The officials at the civil service grade levels of GS-15 will come primarily from the *Gemini* division of the Manned Spacecraft Center here.

It is believed that Air Force Space Systems Div. has asked the space agency to provide initially five or six technical managers.

In addition to those requested for the *MOL* program, the Air Force has also asked that two other officials —with at least one coming from NASA headquarters—be assigned to Holloman AFB, N.M. The latter two will be used to aid the Air Force in its study of advanced manned space missions. One major area of interest in which the NASA personnel will be assigned is in the study of reusable boosters, reliable sources reported.

Transfer of the NASA personnel to the Air Force is part of an agreement announced last year in which the space agency consented to make some of its personnel available to DOD if needed. Some 330 DOD officers are now on duty with NASA.

Only one NASA employee, Michael Yaromovitch, is now on duty at DOD. He serves as special advisor on the *MOL* at Air Force Systems Command headquarters, Andrews AFB, Md.

The request for the relatively highly placed officials reflects the important role they are likely to play in the *MOL* program. Only the very highest program managers of the space agency, such as the overall director of the *Gemini* program here, receive salaries in the GS-16 to 18 range.

It is also believed that as *MOL* moves further into the design and development phase, the Air Force may request more NASA officials.

One of the major positions a NASA employee will fill is assistant to the *Gemini-B* program director at SSD. He is expected to be a top-ranking official in the Manned Spacecraft Center's *Gemini* spacecraft design office.

Another will fill the job of assistant director of the *MOL* engineering division. The person selected—if he accepts—is expected to come from MSC's reliability group.

One major job the Air Force would like NASA to fill is that of special assistant to the chief of flight operations for *MOL*. The NASA official is expected to come from the mission control group at MSC.

No Gemini Program Delay Foreseen

by Hal Taylor

HOUSTON—The failure of the *Atlas* booster during the aborted *Gemini 9* mission is not expected to affect the schedule of the remaining flights in the two-man spaceflight series.

NASA officials said the *Gemini 9* flight would be attempted again in about one week—and that May 31 would be the earliest launch target date.

They are also optimistic that the *Gemini 10* can go off on schedule in mid-July, even though this will mean that it will have to be made ready with only about six weeks for checkout.

The space agency's assessment of the damage wrought when the *Atlas* booster's No. 2 engine swiveled to a hard-over position driving the booster and its *Agena* payload into the Atlantic Ocean on May 17 was made as the agency announced that the *Augmented Target Docking Adapter (ATDA)* would serve as the target for the *Gemini 9*.

Although the exact cause of the engine's swivel malfunction still had not been pinpointed, officials believed it to be a random failure unique to the *Gemini 9's Atlas* vehicle. They did not feel it would force any major design or mechanical change in the *Atlas* vehicle, which has chalked up a record of 49 successful missions out of 52 spaceflight attempts by both NASA and the Air Force.

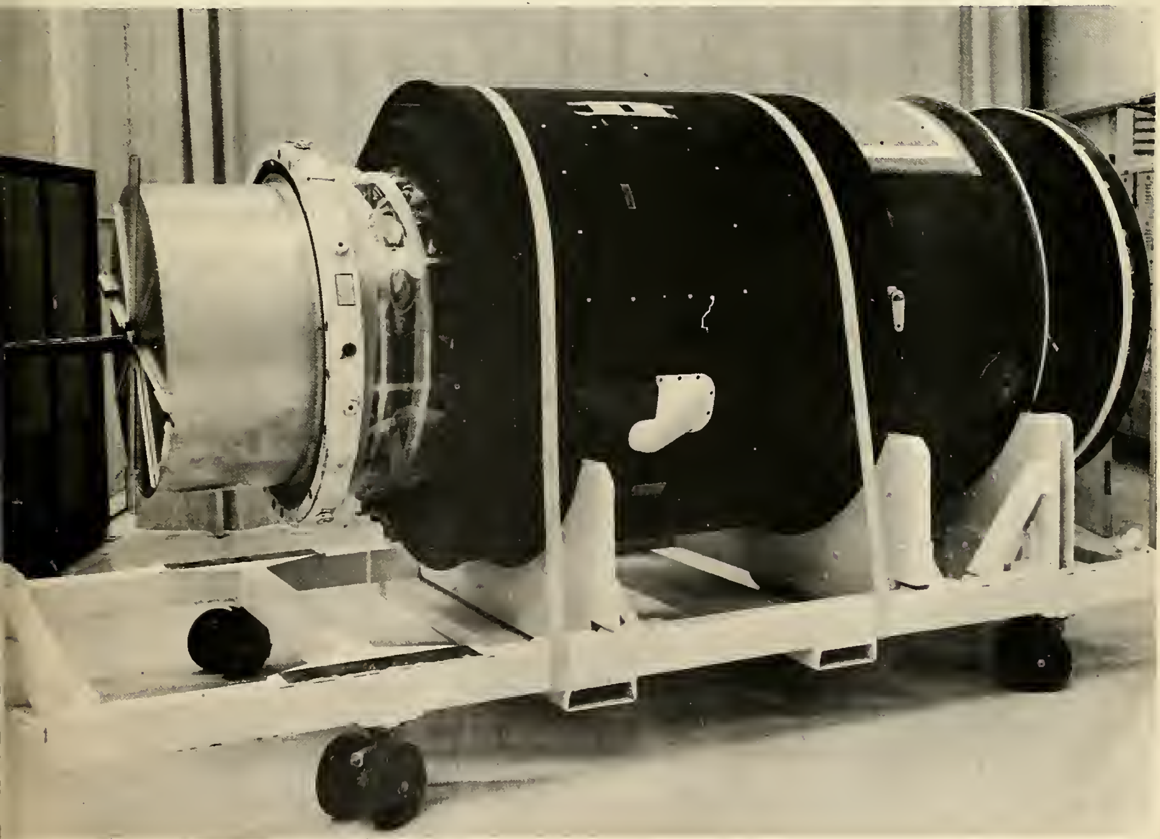
As a result, space agency officials predicted that the *ATDA* would be ready for launch in late May. Since the *Gemini* spacecraft and its *Titan II* booster have been fully checked out, it also should be ready for the targeted launch date.

Schedule factors—The belief that the following *Gemini 10* mission can also meet its planned mid-July launch date is based on the fact that hardware for the shot is already at Cape Kennedy or soon will arrive.

The McDonnell Aircraft Corp.-developed *Gemini 10* spacecraft is already at Merritt Island facilities at the Cape undergoing checkout. Its *Titan II* booster—built by the Martin Co.—was delivered to the Cape last week. The General Dynamics/Convair *Atlas* booster and the Lockheed Aircraft Corp's *Agena* target vehicle arrived at the Cape on May 8 and May 15, respectively.

One problem which might possibly upset the schedule would be extensive damage to either the *Atlas* or *Titan II* launch pads during the *Gemini 9* launch. Any further extensive slippage in the *Gemini 9* flight because of new

The augmented target docking adapter (ATDA), developed by McDonnell Aircraft Corp., will be used for the first time during the rescheduled Gemini 9 mission, now planned for May 31. The ATDA, which has no propulsion system, will be launched by an Atlas.



technical problems would probably also force a slip in the *GT-10* schedule.

If *GT-9* and *GT-10* stay on schedule, *Gemini 11* should follow in mid-September and the final flight in the series, *GT-12*, would go about seven weeks later, early in November.

The use of the McDonnell *ATDA* as a backup target vehicle for the *Gemini* program was reported first by MISSILES AND ROCKETS on Dec. 13 (p. 12).

Its inclusion in the *Gemini 9* flight plan will permit the space agency to complete the planned rendezvous and docking maneuvers as well as the 2-hour, 25-minute space walk by Eugene Cernan. One primary objective of the flight—firing of the *Agena* propulsion system while docked with the *Gemini*—will have to be discarded because the *ATDA* has no propulsion system.

Change in plans—One of the rendezvous exercises will have to be modified. Plans called for a simulation of the rendezvous techniques which will be required to rendezvous an orbiting *Apollo* Command and Service Module with a Lunar Excursion Module rising from the Moon's surface by firing the *Agena* into a lower orbit to act as the LEM. The *Gemini 9* spacecraft was then supposed to rendezvous with it.

Since the *ATDA* has no propulsion system which can be used to change its orbit, the new *GT-9* flight plan calls for the *Gemini* to fire its orbital attitude maneuvering system to place it in a higher orbit than the *ATDA*. *Gemini 9* command pilot Thomas Stafford will then fire his spacecraft thrusters and rendezvous with the *ATDA*.

One experiment will also be dropped from *GT-9* because of the use of the docking adapter. A meteoroid detection panel was supposed to be exposed on the *Agena* and later placed at the relatively high altitude of 205 n. mi. The panels were to be collected later by a future *Gemini* crew, following a rendezvous with the *Gemini 9 Agena*. Since the *ATDA* will be in a relatively low orbit of approximately 160 n. mi., it will probably decay and re-enter the Earth's atmosphere before any valuable meteoroid data could be obtained.

ATDA makeup—The *ATDA* will be launched into a 160-n.-mi. circular orbit.

It utilizes existing flight-rated *Gemini* hardware mounted in a new shell structure. It weighs about 2,400 lbs. at launch and 1,700 lbs. in Earth orbit.

Some of the *ATDA* on-board systems and equipment and the firms which developed them are a standard target docking adapter (McDonnell); *Gemini* C-band beacons and antennas for tracking (Motorola and McDonnell); *Gemini* digital command system (Motorola) for ground-to-space commands and the *Gemini* L-band transponder (Westinghouse) for space-to-space commands; the *Gemini* PCM telemetry system (Electro-Mechanical Research). Stabilization is provided by the *Gemini* reentry control system (Rocketdyne) and the *Gemini* orbital attitude maneuvering system electronics (Honeywell). Power system is the standard *Gemini* batteries (Eagle-Picher).

The *ATDA* structure consists of the *Agena* adapter built by Lockheed, target docking adapter nose fairing, built by Douglas, and the shell of the structure, built by McDonnell.

The use of the *ATDA* will not prevent rendezvous in the third orbit. NASA plans also call for Cernan to use the astronaut maneuvering unit (AMU) during his space walk to move very close to the *ATDA* and perhaps even touch it.

The simulation of a space rescue mission will also be attempted, with Stafford maneuvering the spacecraft toward Cernan while he is in space.

Good beginning—Countdown for both the *Atlas/Agena* and the *Titan II/Gemini* combination was almost perfect on the May 17 launch date for *Gemini 9*. It was marred by only one technical hold when a filter was clogged, slowing down the flow of oxidizer into the *Agena*. The problem forced a 15-minute delay.

When the oxidizer loading was completed, the countdown again moved perfectly and the *Atlas/Agena* blasted off on schedule at 10:15:03 a.m. EST. In the first two minutes of flight everything went smoothly. Suddenly, the little blip on the display panels at Mission Control, which flashed the trajectory of the bird, stopped its straight but slightly high path into orbit and the launch vehicle track began jumping all over the panel.

NASA officials later said the sudden sharp moves of the blip showed the launch vehicle moved erratically off course and there were indications that an explosion had taken place.

The space agency's official statement on the malfunction said that the *Atlas* No. 2 engine at about 120 seconds into the flight swiveled to an extreme hard-over position. The other booster engine and the sustainer engine, acting under autopilot control, continued to work to counter the asymmetrical thrust. After booster separation, the vehicle continued under sustainer thrust but at an angle heading it toward the Earth. It also had rolled to a position in which ground guidance could not lock on its antenna.

The space agency said it then sent a sustainer cutoff and a signal to prevent ignition of the *Agena*. These were acted upon.

The *Agena* separated on schedule and both the booster and the upper stage reportedly plunged into the sea. ■

New Exercises Under Consideration for Future Gemini Flights

NASA is expected to add some new wrinkles to future *Gemini* flights including putting *Gemini* piloting skill and equipment performance to the supreme test during the *GT-12* mission when pilots will attempt to rendezvous with an *Agena* with virtually no assistance from ground tracking stations.

Pilots on that mission, or perhaps on an earlier flight, may tether their spacecraft to an *Agena* target and set themselves into slow rotation, inducing a gravity gradient to demonstrate a minimum-energy station-keeping technique applicable to the repair or inspection of non-dockable satellites in orbit.

Despite NASA's statement to the contrary, there is also some possibility that during the final mission in the program an astronaut during extravehicular operations may unhook himself from the tether to further explore the capabilities of the Air Force Astronaut Maneuvering Unit (AMU).

In the *GT-12* orbital determination experiment, the crew, prior to spacecraft liftoff, will have only crude data on the *Agena* target orbital position loaded onto their onboard computer and backup charts.

At the time of insertion into orbit, the two vehicles will be approximately 280 n. mi. apart, but approaching the range capability of the rendezvous radar of the spacecraft. Once radar lock-on is achieved, the pilot will then drive the spacecraft in toward the target with the goal of rendezvousing with the *Agena* during apogee.

Space agency officials also report that while some people are still discussing rendezvousing *Gemini 12* with the first manned *Apollo* spacecraft, there is little likelihood this will be done. Launch schedules now indicate that *Gemini 12* will be launched much sooner than the *Apollo* and there appears to be no sound reason to delay the flight simply to achieve the rendezvous.

Future Power System Funding Outlined

WASHINGTON, D.C.—Some $311 million is expected to be spent by the Atomic Energy Commission in the area of satellite and small power sources (SNAP) programs during the Fiscal Years 1968 through 1970.

In data submitted to the Joint Congressional Committee on Atomic Energy, the AEC estimated that for these years, the space electric power systems funding will amount to $255.5 million, with another $55.5 million going to terrestrial auxiliary power systems.

The funding breaks down into $230 million for operating costs, $15 million for equipment and $66 million for facilities. The addition of $331 million will bring the AEC's expenditures in the SNAP area to $775.3 million, $696.1 million of this going to space.

Long-range funding estimates for the space propulsion category, or Rover, put costs for that program at $327.5 mililon during the Fiscal Years 1968 through 1970, with a cumulative total at that point of $946.2 million.

The FY '68 through '70 projection breaks down into estimates of $97.5 million for advanced research and technology, $176 million for NERVA, $27 million for Nuclear Rocket Development Station support, $9 million for construction, and $18 million for equipment. No funds are included for Kiwi.

Recommendations made—The JCAE also disclosed that the Atomic Industrial Forum Ad Hoc Committee on the Nuclear Space Program has concluded that at the present rate of development, fully qualified space reactor systems will not be available before 1980.

However, the group, which was chaired by Russell D. O'Neal, vice president for aerospace systems for the Bendix Corp., said that a qualified system could be made available by 1975 if planning for an integrated system were undertaken in the near future.

The committee also recommended that in order to translate current state of the art into available space power systems to meet needs in the low-kilowatt range, the AEC should initiate development of a reactor power system in this power range.

The group also pointed out that isotopic power supply systems have attracted a mounting interest in the past year, with the alpha emitters, such as plutonium 238 and polonium 210 particularly attractive to systems designers because of minimum handling problems and shielding.

However, a major barrier stands in the way of their acceptance because of uncertainty over their availability. The AEC was urged to step up its efforts to get accurate cost and availability estimates.

Should isotopes be in short supply, the committee also pointed out, compensation could be made by improving the efficiencies of thermal to electric conversion systems, which should be an object of continuing effort.

It also said that a more concerted effort on fuel form development work is clearly needed, and that it was concerned about the tendency to de-emphasize this work.

In discussing nuclear rocket stages, the ad hoc committee expressed the view, which was adopted by the JCAE in its authorization report recently (M/R, May 9, p. 14), that nuclear engines should be employed in "stepping stone" missions, such as unmanned probes and systematic lunar exploration, so that engine reliability will be achieved prior to a manned Mars landing mission commitment.

It asked that NASA examine potential manned and unmanned missions, with an eye to establishing an early intermediate mission requirement from which essential operational experience may be acquired for later missions.

It will be 1985 before electrical propulsion systems would be available for manned interplanetary missions, at the present level of effort, the group said. It called for stress of component technology with complete system development proceeding as rapidly as the technology indicates required lifetime and specific weight can be achieved.

Requirements go-round—The group also pointed out that the nuclear energy program for space is full of examples of programs which died on the vine because the user agency could not come up with a firm requirement for them.

The Aircraft Nuclear Propulsion program was a classic case, it said, costing over a billion dollars and lasting over 12 years—and incidentally weathering some 23 ad hoc review committees.

The nuclear ramjet Pluto was characterized by solid technical accomplishment in its 10-year lifespan, during which almost $200 million was expended. However, the project was cancelled when an apparent disappearance occurred of a previous Air Force requirement.

In attempts to justify the funds needed for continued development, and to prove that the system being developed will be useful in an operational sense, "there has been a tendency to set system requirements which are too advanced in terms of the status and pace of the technological effort," the report stated.

The AEC also has listed for the committee all the projects costing $10 million or more which were discontinued in the last 10 years. In addition to the nuclear airplane and Pluto, it included the Army gas-cooled reactor systems program (AGCRSP), the flexible experimental prototype gas-cooled reactor (EGCR), the military compact reactor (MCR), the liquid metal fuel reactor (LMFR), the aqueous homogeneous reactor; the sodium graphite program and the medium-power reactor experiment. ■

Final BUIC System Installed in Nevada

Another building block in the North American air defense complex was completed May 20 when the Air Force Systems Command's Electronic Systems Div. turned over the last of 13 Back-Up Interceptor Control (BUIC) facilities to the Air Defense Command.

Located at Fallon Naval Air Station, Nev., the final BUIC facility has counterparts strategically located throughout the U.S. and Canada. Installation of the multi-million-dollar system will be carried out under the direction of ESD's 416M system program office.

Each BUIC site is co-located at an existing Semi-Automatic Ground Environment (SAGE) radar installation. This dispersal technique insures the system's survivability in case of mass enemy air attack. BUIC is a back-up system which remains in a monitor status as long as SAGE is operating. Should a SAGE site be destroyed, BUIC will utilize the same information and automatically switch from monitor to operational mode.

Burroughs Corp. is prime contractor for the system. System engineering was provided by the Mitre Corp. and computer programming by System Development Corp.

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ELECTRONICS

Ring Laser Gyro Delivered

Sperry Rand's ring laser gyroscope, said to be the first system of its kind to display performance comparable with conventional missile and space guidance/navigation gyro systems (M/R, Feb., 18, 1963, p. 24), has been delivered to the Avionics Laboratory, Air Force Research & Technology Div., Wright-Patterson AFB, Ohio. Developed by Sperry's Electro-Optics group, the $100,000 system will now go through extensive bench tests by Air Force engineers. Sperry reports that the device, billed as a high-g-resistance unit, has withstood centrifuge accelerations over 100 g's. Resolution of the system is claimed to be better than 1 arc.-sec./sec. The laser gyro package measures 11 in. by 25 in. by 2 in. and weighs less than 20 lbs. Further weight and size reductions have already been made, Sperry officials say.

Astronaut/Astronaut Radio Under Test

Three prototype models of a small radio communicator developed by Westinghouse Electric's Aerospace Div. are being tested by the Communications Branch, Electronic Warfare Div., Air Force Avionics Laboratory. The personal communications system, designed for in-space use between astronauts, consists of two separate units—a helmet transceiver containing all the electronics and a power and control unit. The transceiver has two receiving channels and seven transmitting channels. One receiving channel is assigned as a common guard. The second one is assigned as a private address channel. A priority interrupt feature on the guard channel allows for emergency transmissions. The transceiver can be operated by a voice-activated switch or a manual push-to-talk control mounted on the power/control unit worn outside the space suit. The system has a line-of-sight range of one mile. The molecular-electronic construction has a mean-time-between-failure rating of 32,000 hrs.

MATERIALS

GE Die Casts Ferrous Metals

Using their experience with refractory metals, metallurgists at General Electric Co.'s Lamp Metals and Components Dept. are developing an ability to die-cast ferrous metals. Over 100 castings have been poured with gray iron using refractory metal molds. The GE department uses a 100-ton, cold-chamber, die-casting machine with a refractory metal shot sleeve and plunger in the experimental program. Current plans call for using the equipment to develop the necessary technique for die-casting ferrous alloys and in testing new refractory alloys for the casting process. The firm does not intend to move into the casting business but does aim to provide and perfect the metals and alloys needed for the successful die-casting of ferrous metal.

Avco Moves Into Coal Research

A new method for increasing the utility of coal by converting it to higher-value gas and liquid products will be explored by Avco Corp.'s Space Systems Div. under a $1,821-million contract with Dept. of Interior's Office of Coal Research. Avco will molecularly fragment coal in an electric arc reactor. The first phase of the projected three-phase effort will include collection of preliminary data on yields, energy requirements and operating characteristics. Several types of coal will be converted in a 50-kw arc. Extensive operating data will be accumulated in the second phase, to optimize the design of an electric arc reactor. If both phases are successful, Avco will then build and operate pilot-scale equipment with a processing capacity of 10 tons per day. This phase will supply the data needed to adapt the Avco conversion method to large-scale commercial production.

SPACE MEDICINE

Air Force Rules Out Space Diet in Test

New coatings for bite-size foods must be developed before an all-bite-size feeding system can be recommended for manned spaceflight, Air Force doctors conclude. Reporting a recent two-month simulated space voyage at the Air Force School of Aerospace Medicine, researchers said that the fat coatings presently used to maintain the integrity of bite-size foods are poorly utilized and may be responsible for elimination frequency. Intestinal cramps and abdominal pains, so severe on several occasions as to keep crew members from performing efficiently, were attributed to certain beverages used as supplements to the diet.

LIFE SUPPORT

First Two-Gas System Scheduled for Delivery

Delivery of the type II gas management assembly for the General Electric-developed *Biosatellite* vehicle is expected to be made by subcontractor Hamilton Standard Div. of United Aircraft Corp. sometime this fall. The unit, which will provide oxygen and nitrogen at sea-level pressure to animal experiments for periods from 21 and 30 days, weighs 33 lbs. for the 21-day mission and 45 lbs. for the 30-day primate experiment. The unit contains the first two-gas control system developed for an approved space project, and selects and controls oxygen and nitrogen required to maintain the correct proportions. The external storage systems for the two gases are jettisoned just before re-entry of the *Biosatellite* vehicle.

Lunar-Vehicle Fallout Aids Amputees

Space-General Corp.'s research on a "Moonwalker" as part of the original *Surveyor* concept has paid off in a contract for an eight-legged "walking chair" for use by amputee and paraplegic children from the U.S. Department of Health, Education and Welfare. The artificial legs operate in pairs, each of which is driven by a double-face cam assembly for both horizontal and vertical movement. The vehicle can move over almost any terrain, up curbs and rough slopes of better than 15 degrees, with a maximum speed of two miles per hour. The battery-powered vehicle can be operated with a stick moved by hand, foot or chin.

Contaminant Generation Simulated

A trace contaminant generator, used by the Manned Spacecraft Center to simulate possible contamination problems of closed spacecraft or test chambers, has been constructed by Honeywell's Systems and Research Div. The unit, which is designed to operate in 5 psi 100% oxygen, or 7 psi oxygen/nitrogen, can deliver any 10 compounds out of 80 contaminants specified by MSC technicians. Provisions are being made to install 10 more channels. Each delivery channel permits trace material metering in the range of 10^{-6} to 10^{-2} gram-moles per hour. Delivery accuracy is said to be ±10%, reduced to ±5% at higher deliveries.

Apollo Lunar Flight Package Readied

by Heather M. David

Los Angeles—Delivery of the first lunar mission *Apollo* life-support system will be made to North American Aviation, Inc., this month by contractor AiResearch Manufacturing Co., a division of Garrett Corp.

The block II life-support system differs from previous systems, such as those used in *Gemini* and *Mercury*, in several ways:

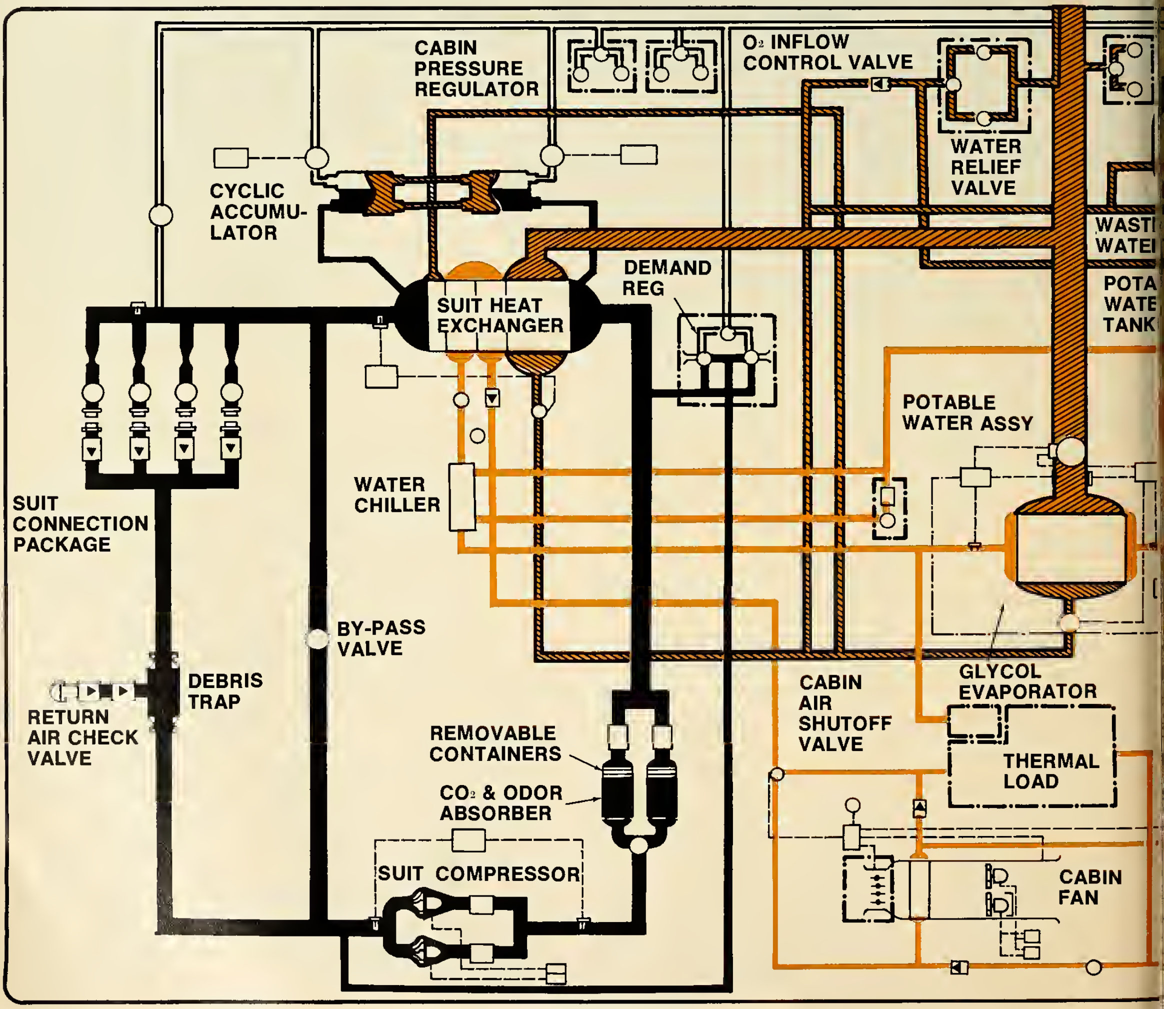
—The system must be designed for the possibility of a four-day abort time since an *Apollo* spacecraft headed for the Moon must still complete an orbit around the Moon even if a decision is made not to attempt the landing.

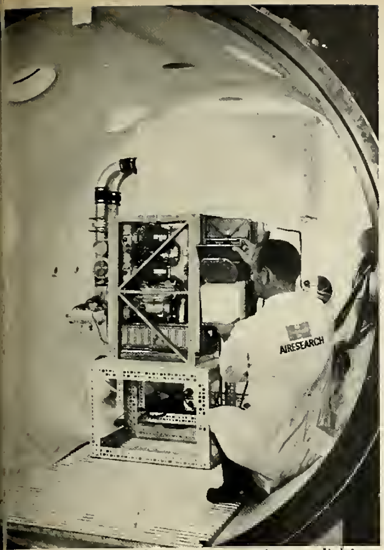
—Modular design is used as much as possible for better access for removal and replacement. Most of the system is divided into four packages that can be easily handled.

Mission—Function of the environmental control system is to maintain the temperature of the Command Module at between 70° and 80° F, with a maximum of 90° F during re-entry, and humidity between 40 and 70%. Atmosphere is 100% oxygen at 5 psia.

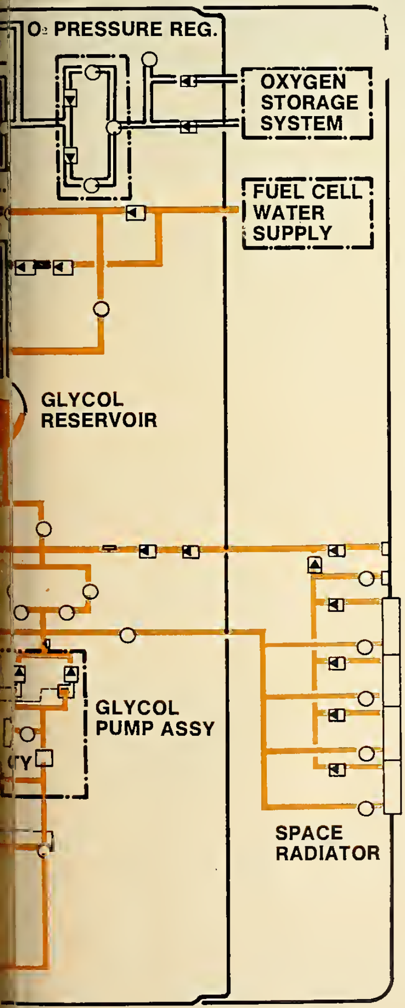
Unlike its predecessors both in the national space program and at Garrett, the *Apollo* system is the first designed for operation with the crew primarily in shirtsleeves. Operation of the system is essentially the same whether or not

Environmental control system for initial lunar Apollo mission, is scheduled for delivery to North American this month.


CABIN PRESSURE REGULATOR
O_2 INFLOW CONTROL VALVE
WATER RELIEF VALVE
WAST
WATE
CYCLIC ACCUMULATOR
DEMAND REG
SUIT HEAT EXCHANGER
POTA
WATE
TANK
POTABLE WATER ASSY
SUIT CONNECTION PACKAGE
WATER CHILLER
BY-PASS VALVE
DEBRIS TRAP
RETURN AIR CHECK VALVE
CABIN AIR SHUTOFF VALVE
GLYCOL EVAPORATOR
THERMAL LOAD
REMOVABLE CONTAINERS
CO_2 & ODOR ABSORBER
SUIT COMPRESSOR
CABIN FAN



Technician exchanges one of two lithium hydroxide CO_2 absorbers.



the spacesuit connections are attached.

Because of the lengthy abort requirement, design must be such that the system can be controlled, regulated and repaired, if necessary, with the crew in pressurized spacesuits for as long as four days.

Emergency features include an oxygen surge tank to provide an immediate supply of oxygen in the case of meteorite puncture or other loss of pressurization, as well as redundancy in key subsystems in case of malfunctions.

The Earth orbital or block I version, with a slightly less stringent requirement, differs from the block II unit in that it has only a single glycol cooling loop instead of two. Provisions also are made for other block II equipment. Differences in the two systems amount to about 10% of the total design.

Both have another unique emergency provision stemming from the fact that the *Apollo* spacecraft could come down in a recovery area on the opposite side of the world than originally planned with recovery forces deployed many hours away.

The capsule has a post-landing ventilation system, and two inlet valves and an exhaust port which may be opened when the astronauts have touched down. A battery-powered fan, capable of operation for two days, is provided to circulate air.

Design for the block II system was frozen in December, 1965, although block I design was firm some two years ago. The block I unit has been flown on the unmanned *Apollo* flights. While there was no way to test its capability in terms of a crew, telemetered data proved that it successfully cooled electronic gear.

All rotating equipment has undergone thousands of hours of life testing, Garrett *Apollo* project director Charles Clarke told MISSILES AND ROCKETS. The entire systems have been run with Garrett's three-man simulator, or "man can."

In addition, a three-man simulated 14-day mission was carried out successfully at North American Aviation's *Apollo* checkout facility.

Oxygen supply—Oxygen is fed to the cabin from a cryogenic oxygen supply at response of a cabin pressure regulator that keeps cabin pressure at 5 to 5.5 psia.

Normal leakage in the *Apollo* capsule is 0.5 lbs./hr., maximum. However, the system is designed to take a leakage rate of 0.67 lbs./min., the rate calculated for a puncture in the cabin wall ½ sq. in.

In the event of a meteorite puncture, an increase in oxygen flow rate will automatically trigger the opening of a valve on a gaseous oxygen surge tank, which will maintain cabin pressure for five minutes at the maximum flow rate. This would allow crew members to don suits or patch the wall.

Oxygen is stored in the surge tank at 1,000 psi, rather than in cryogenic form since the latter would require some time to be ready for use. Oxygen in the oxygen supply system is used at 20 psi to move water and glycol from tanks to various parts of the system.

The potable water tank, for instance, is equipped with a bladder of oxygen which forces out water as needed. The oxygen supply system is also used as a source of pressure in case of a leak in the glycol cooling system. A rubber diaphragm, which separates the glycol and a source of oxygen in the glycol reservoir, forces glycol into the system when required.

There are two blowers in the suit circuit, as well as two in the cabin. The air stream is moved at a rate of 35 cu. ft./min. by the suit compressors and 90 cu. ft./min. by the cabin fans. Power required by the blowers is a maximum of 85 watts, with 28 watts for operation of each cabin fan.

Oxygen is supplied to the suit circuit after passage through three flow limiters. After use, it is returned to the suit blowers, which send it through a debris trap and then over the carbon dioxide absorbers.

As with *Gemini* and *Mercury*, lithium hydroxide canisters are used for removal of carbon dioxide. However, while with *Gemini* all the granules used for the mission were carried in one canister, the *Apollo* system is divided into small canisters capable of operation for 24 hours each.

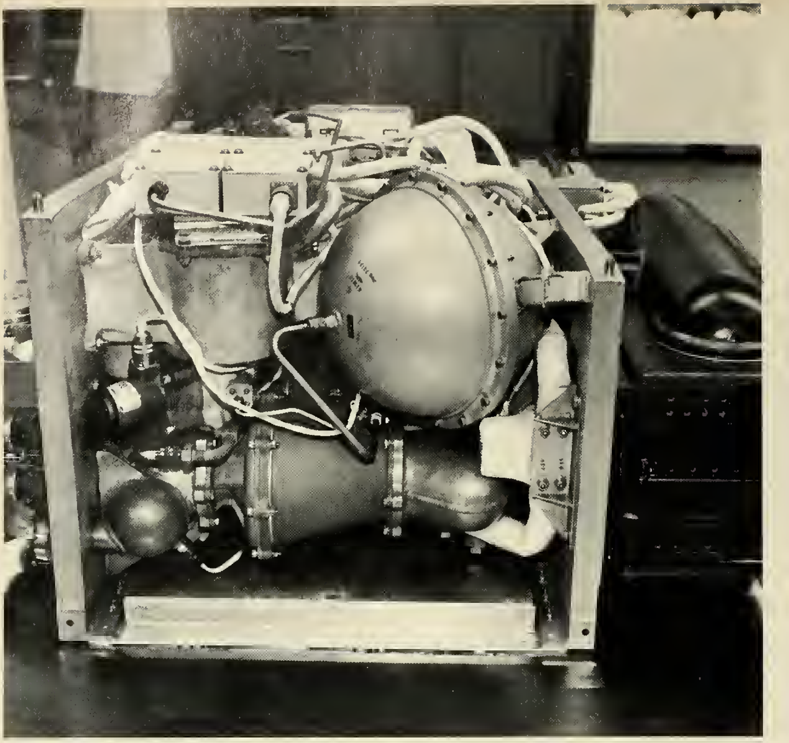
About 20 canisters will be carried on the lunar mission. Two are in operation at all times. One is changed by the crew every 12 hours.

Philosophy for the design change is that the small canisters can easily be replaced on the pad in case of a long hold before launch. Thus, the entire supply would not be wasted if a long hold caused usage of one portion.

While in operation, the air stream passes over the two canisters simultaneously. However, the system is designed so that access cannot be made to one canister unless the air stream is sealed off the affected side and is being passed over the other canister.

The lithium hydroxide canisters, described by the company as resembling grocery strawberry baskets, are 8 in. square, and 5 in. deep. A filter membrane covers the absorbent, which in addition to LiOH includes a ⅛-in.-thick layer of activated charcoal at the base to handle trace contaminants.

Rate of use of the canisters is both telemetered to the ground and shown



End view of environmental control unit shows glycol reservoir (sphere in center), suit compressors directly below reservoir and lithium hydroxide canisters at right.

on a display in the Command Module.

Cooling system—After purification, the oxygen stream passes through the suit heat exchanger, where water is removed by condensation.

The droplets are trapped by wicks which move away from the heat exchanger and pumped by cyclic accumulators which work like vacuum-operated windshield wipers.

The glycol cooling system, Clarke points out, has a faster response than just the water evaporator used on previous systems. Suit temperature control was a problem never really solved in the *Mercury* program.

The *Apollo* system also differs from the *Gemini* system, which also used glycol for cooling, in that it has more capability for supplemental cooling in case of the loss of the radiators. The boilers or evaporators that cool the glycol can be cooled with water if necessary.

The block II system is supplied with two completely redundant glycol loops complete with evaporators. These are completely isolated from each other and are on different circuits. Switchover is manual.

Glycol is used in the spacesuit heat exchanger, is sent to the drinking water supply for chilling, to the cabin cycle and to electrical heat loads. It is cooled at the space radiator, but if this is not sufficient, the evaporator provides additional cooling.

A unique feature of the system is the magnetic drive on the glycol pump, designed to keep glycol from fouling the motor. The magnetic drive, enclosed in a plastic seal, drives an impeller which rotates at 12,000 rpm. It operates at 29.5 psi and produces a 200 lbs./hr. flow.

There are three pumps in the block II system and two in the block I system. Power requirement is 35 watts per pump.

Water—The only difference in the block I and block II system water supply is the fact that there is somewhat less water in the system because of the absence of the Lunar Excursion Module fuel cell on the Earth orbital missions.

The system fills the potable water tank first, bleeding excess into the waste water tank, where it becomes a source for the water boiler system. A relief valve also is provided if too much water is produced. Waste water also goes to the glycol evaporator for supplemental evaporative cooling.

Some filtering is done, although the fuel cell water is considered equivalent to distilled water. However, there is some concern where water remains in such places as the heat exchanger that some microbiological contamination might result. This problem is being studied. At this time, though, the filtering is done mainly to keep the system moving, since there are many small valves and orifices.

Although some thought had previously been given to installing a dehumidifier in the *Apollo* Command Module, it now appears that this will not be necessary.

A catalytic burner designed for the *Apollo* also does not appear likely to be used, although a trace contaminant sensor is expected to be incorporated into the system. All materials in the environmental control system are on the NASA approved materials list.

AiResearch is also prime contractor for the *Apollo* Applications Program environmental control system, which will be a two-gas system probably using nitrogen/oxygen at 5 psi. Company officials said that about 80% of the system is common with the one-gas *Apollo* lunar mission unit. ■

CO_2 Monitor is Small

Monitoring of carbon dioxide in the *Apollo* Command Module will be accomplished with a miniature CO_2 sensor occupying only 40 cu. in. and developed by Perkin-Elmer's Electro-Optical Div.

The sensor detects the infrared attenuation of the sampled atmosphere at two narrow wavelength intervals—one corresponding to an absorption band unique to carbon dioxide, the other located in a window where no normal atmospheric gases absorb.

The instrument develops an output proportional to the CO_2 concentration by computing the ratio of the two attenuation values. Accuracy is guaranteed with use of a dual-wavelength filter that alternately interrupts the infrared beam in the sample path.

Total power input is only 1 watt at 28 volts dc. Perkin-Elmer attributes the low power drain to the use of transistor types with high gain at operating currents of only a few microamperes. Electronic circuits are solid state and stable over a large temperature range.

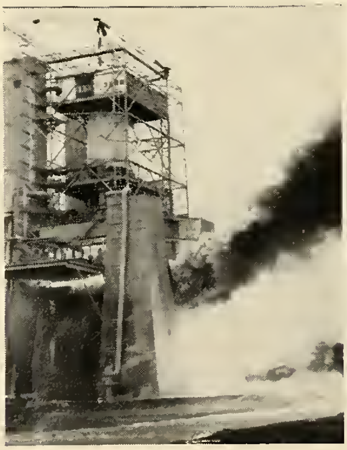
Perkin-Elmer also recently won a contract, along with SDS Data Systems, for $300,000 each to build prototypes of two-gas sensing systems for use on future manned spacecraft for periods of 45 days or more. The NASA contracts are from Langely Reseach Center.

BOEING 737
737

AMERICA'S newest, most advanced short-range jet, the Boeing 737, will bring passengers on short-range routes the same big-jet comfort enjoyed by passengers on intercontinental jetliners. The 737 will provide more head room, more shoulder room by far than any other short-range jet. It'll carry up to 117 passengers, cruise at 580 miles an hour, and operate with ease from shorter runways. Roll-out is scheduled for later this year. Boeing 737s have already been ordered by these leading airlines: Braathens (Norway), Irish, Lufthansa, Mexicana, Northern Consolidated, Pacific, Piedmont, United, Western and Wien Air Alaska.

Capability has many faces at Boeing

CHINOOK helicopter, built by Boeing's Vertol Division, is operating in Viet Nam with the 1st Cavalry Division (Airmobile). Chinook is U.S. Army's standard medium transport helicopter.



TEST firing of world's most powerful rocket stage, the S-1C booster of NASA's Saturn V which will launch first Americans on moon journey. Boeing holds NASA contract to build, develop, test S-1C stage, generating 7.5 million pounds of thrust.

85-FOOT antenna near Madrid, part of worldwide Deep Space Network, is one of three which will receive transmissions from NASA's Boeing-built Lunar Orbiter as it circles and photographs moon later this year. NASA has also assigned Boeing responsibility for space flight mission operation.

BOEING

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Ames Flight Simulation Lab To Be Operational in January

FIRST OPERATIONAL USE of the Advanced Flight Simulation Laboratory, now under construction at NASA's Ames Research Center, will be January, 1967.

The total value for the four major facilities to be housed in the 93,000-sq.-ft., $3.2-million structure will be $10,068,000.

Field installation of the $6.5-million "50-g" centrifuge, or Man-Carrying Motion Generator (MCMG) is now being done by Genisco Technology Corp., MCMG prime contractor.

The three-man cab on the centrifuge will produce five of the six possible types of motion and is designed to simulate missions beyond the current *Apollo* program—as are all the facilities in the new center.

The cab will be as well equipped as an actual spacecraft and will present the crew with all the environmental stresses and sensations of spaceflight except weightlessness.

Facility detailed—Crew members will encounter all "out the window" stimuli of spaceflight such as solar radiation and celestial navigation objects. The machine will produce the high gravity forces of emergency mission terminations, simulate cabin pressure losses, heat and pressure buildups, changes in humidity and cabin gas mixtures and explosive decompression.

The centrifuge is housed in a 124-ft.-dia. rotunda and powered by an 18,600 hp d-c generator built by Westinghouse Electric Corp.

A smaller one-man cab will be used for g-loadings above 20 to gain basic data on human reactions to a variety of conditions under such extreme forces. Flights of any duration at these g-levels are extremely unlikely.

Soft landings and other decelerations will be handled by a special hydraulic brake system designed by Goodyear Tire & Rubber Co. The brake will provide decelerations from 56.5 fps to zero in 0.2 second.

The brake system consists of a disc 32 ft. 4 in. across with six brake assemblies spaced around the circumference. Fabricated in 24 segments and machined to precise thicknesses, the steel disc fits around and attaches to the rotating support/drive column of the centrifuge.

The six brake assemblies will be mounted on the centrifuge room foundation with each having 14 pads 4 in. in diameter and each pad being actuated by an individual piston having a hydraulic pressure of 3,600 psi.

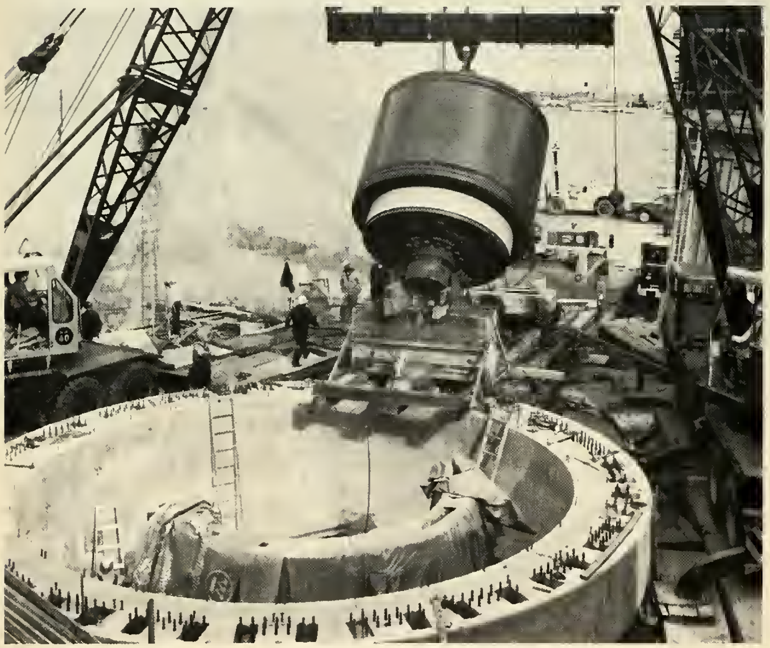
Despite the high torque—14 million lb.-ft.—the brake system is designed for 10,000 applications before any part replacement is necessary.

Other installations—In addition to the centrifuge, the Ames center will have a Mid-course Navigation Facility housing another three-man capsule and simulating celestial navigation techniques as closely as possible.

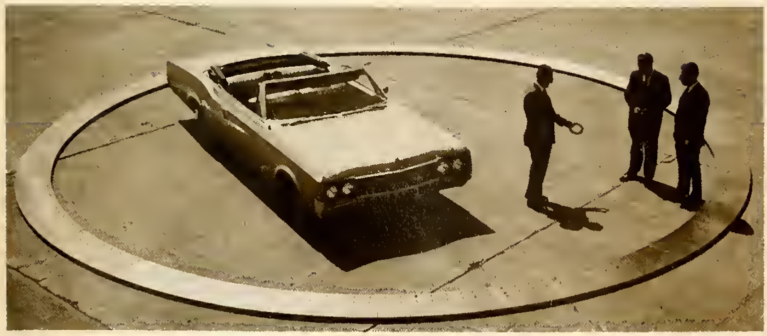
A four-story Advanced Aircraft Simulator is being installed by American Machine and Foundry Co. capable of duplicating virtually all aspects of supersonic transport flight.

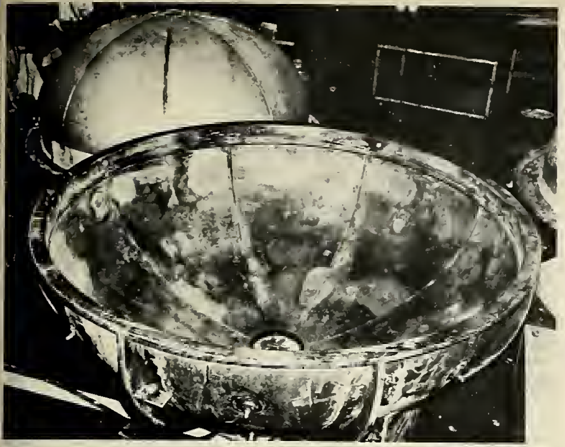
The last major facility is a satellite attitude control unit being built by American Optical Co. This facility will test advanced control systems in realistic environments using a vacuum chamber and a finely balanced 8-ft.-dia. test table supported by an air bearing.

All types of orbits with apogees out to 10,000 mi. and rotation times up to once a day will be simulated. The chamber will have three star simulators adjustable up to sixth magnitude. ■



ABOVE: *Rotor for Westinghouse motor being installed at Ames facility. The huge motor will generate forces up to 20 g's while whirling a three-man capsule at the end of a 50-ft. boom.* BELOW: *Large disc for centrifuge's brake system is shown at Goodyear plant, with standard automobile for size comparison.*





The concave age-forming/bonding tool is shown with the welding tool in the background.

One of the bulkheads formed by the new process which avoids skin-to-core mismatch problems in composite structures.

SPACE STRUCTURES

New Method May Solve Mismatch

A CONCEPT OF FABRICATION under tensile stress promises to eliminate the skin-to-core mismatch which has plagued manufacturers of large composite structures.

The method uses vacuum and autoclave pressure to hold preformed, welded, sandwich elements in place under tensile stress during bonding and aging. Final forming and aging of the welded skin panel is handled under tensile stress similar to age-forming.

Feasibility of the technique has been proven through a joint program involving the Manufacturing Engineering Lab of NASA's Marshall Space Flight Center and the Wichita Branch of the Boeing Co.

Saturn bulkhead—The work included a minimum of design for a 105-in.-dia. composite bulkhead—the type of insulated partition required between liquid-oxygen and liquid-hydrogen tankage on launch vehicles—for the purpose of approaching spaceflight hardware while evaluating dimensional behavior during fabrication.

The bulkhead was designed and made from 2219 aluminum alloy skins chem-milled on one side to a 0.060-in. thickness except in the weld land areas. The weld areas retained a nominal 0.090-in. thickness.

Eight core segments per face sheet were welded into shells. The face sheet shells were adhesively bonded with Bloomingdale HT-424 adhesive to a 1-in.-thick heat-resistant phenolic (HRP) honeycomb core after the weld beads were hand-machined flush.

The aluminum alloy shells were deliberately made slightly undersize with respect to the concave bonding and aging tool—the key operation.

Technique—The final form was fixed in the concave forming and aging tool by age-forming the outer skin under vacuum and 60-psig autoclave pressure at 325°F for 16 hours. The honeycomb was then bonded to the outer skin with the adhesive for one hour at 30 psig. The inner skin was final-formed against the core at 60 psig for 16 hours at 325°F and then bonded to the core with the adhesive for one hour. No core machining was required.

Additional cure and aging times were applied to the inner skin and assembly to approach the desired minimum inner-skin aging time of 24 hours and to provide maximum corrosion-resistance in the alloy.

Measurements of the welded skin assemblies were taken in the free state, under vacuum, after aging and after bonding into the assembly. These were compared with the inside contour of the concave bonding-and-aging tool as the dimensional base.

The tool itself was made from glass fiber-reinforced epoxy plastic. It not only withstood the vacuum and autoclave pressures at temperature, but proved to have relatively the same linear coefficient of expansion as the aluminum alloy.

An aging growth allowance of 0.001 in./in. for the 2219 alloy was the only compensation made in the plaster masters used to establish dimensions, tool contours and adaptation for welding.

Two bulkheads were fabricated in the program. Both were measured radiographically and visually inspected and coin tap-tested. One bulkhead was destructively tested by pulling the skin from the core. The second unit was delivered by Boeing to Marshall in the concave aging-and-bonding tool.

Although the delivered bulkhead was not required to have actual dimensions within the working tolerances of the bulkhead design dimensions, it met normal tolerances except for trim allowances. No machining of the core was required to achieve proper fit.

NASA and Boeing experts claim it now appears feasible to produce large-scale composite bulkheads with production tolerance requirements completely met if the techniques, conclusions, recommendations and technical data collected during this R&D effort are properly utilized.

Future age-forming and age form-sizing applications have received preliminary testing by Boeing. One application uses the age-hardenable titanium alloy 6AL-4V—reportedly with even greater success than was achieved with aluminum.

Charles N. Irvine of NASA and Raymond F. Cox of Boeing, in charge of the joint effort, said the results of X-ray and destructive tests show that if reasonable care is taken to remove the step-offs caused by weld bead projections against the honeycomb core, an overall excellent bond will occur. ■

Non-Profit SDC Expands Market Base

by James L. Trainor

SANTA MONICA, CALIF.—System Development Corp. President Wesley S. Melahn is confident that, even with termination of the not-for-profit's special relationship with the Air Force, the company will be able to prosper.

"We have no great ambitions to get any larger," the SDC president told MISSILES AND ROCKETS, "but we do think that we will be able to compete. Our salaries are comparable to those in industry and our overhead is also competitive."

While the Air Force provides 82.5% of SDC's revenue and the Defense Department as a whole 96.5%, Melahn sees the company's future as an effective contributor "to a wide range of worthwhile projects in such fields as education, law enforcement, regional planning and in assisting state and local governments in the solution of important problems."

He also expects a continuing military business based on the company's experience and demonstrated competence, particularly in air defense, where the company has worked in a privileged position on the Semi-Automatic Ground Environment (SAGE) and the Back-Up Interceptor Control (BUIC) systems.

Need established—In turning to other governmental, state and local organizations for future business, Melahn cites three factors as decisive in establishing the need of these organizations for the computer systems design competence of SDC:

—Reduction in the cost of computer hardware, which allows many more potential users to buy hardware tailored to their needs.

—Development of time-sharing concepts (in which SDC and Massachusetts Institute of Technology's Project MAC did pioneering work) in which many users have access to a central computer. This brings the cost to the user down by another order of magnitude.

—Military work in the computer field has clearly demonstrated that computers are useful, thus melting much of the resistance of people not experienced in computer uses.

Citing SDC's work over a wide range of information sciences and technology and for a wide range of clients (more than 90), Melahn explained the company's role as providing these organizations "with highly qualified technical assistance, which will contribute to the solution of important public problems. This assistance takes the form of design and development of computer-based information-management systems, the design and implementation of training programs and the application of such techniques as systems analysis, simulation and computer programming."

The phrase "important public programs" is an important one to SDC officials, and one they stress repeatedly. The company does not intend to compete for normal commercial business (although Melahn admits that this could change at some time in the future), but will deliberately restrict its set of customers to public organizations or non-profits, such as hospitals, which can use the specialized services the firm can provide.

This restriction is so severe at present that if SDC were asked to take a subcontractor role to a major hardware manufacturer on a public program, the company would reject the contract. The reasoning, Melahn says, is that SDC must enjoy a close, unfettered relationship with the client in order to advise him most effectively.

"The prime naturally wants to sell his hardware and so he would tend to act as a buffer between ourselves and the customer. In this case, this is something we would have to work out with the customer.

Not a snap decision—Although the change in SDC status was first brought to public attention last month in the report of the *ad hoc* group of the Air Force System's Command's Board of Visitors on Air Force relations with the not-for-profit corporations (M/R, April 25, p. 14), both parties were aware that a change was needed.

"Several years ago the Air Force and we took a look at the future Air Defense Command programming needs and came to the conclusion that by 1967 the workload would have dropped off substantially and there was nothing coming along to take up the slack," an SDC executive explained.

The impetus for this examination appears to have been provided by a special committee created by the Secretary of the Air Force in 1964 to examine the overall AF relationship with SDC including the possibility of merging SDC and Mitre Corp. Such a merger, it was felt, would create an organization with "the size and depth of competence and specialized position to accomplish the systems engineering and intersystems integration needed to create a cohesive national command/control system."

Chaired by Bert Goodwin of the General Counsel's office, the committee instead was instrumental in the issuance of a Secretary of the Air Force memorandum recognizing SDC's unique character and exempting it from an earlier policy memo which equated it with the systems engineering/technical direction (SE/TD) roles played by Mitre and Aerospace Corps. It was a victory for the company in that it recognized SDC's independent status and supported the not-for-profit's contention that it differed from the SE/TD, single-customer organizations chartered with Air Force sponsorship.

"This sponsorship has always been an implied Air Force attitude," Melahn says, "but we've always considered ourselves an independent entity, a private organization. We're not like Aerospace and Mitre. We've always been different, although unfortunately people have tended to lump us together. We've never had the single-customer relationship with the Air Force that they have. Almost from the start, we have had a number of customers."

Fade away or branch out—With recognition of the diminishing character of the air defense business, SDC's board of trustees "thought very hard" over the past several years of what the company's future should be. Melahn says alternatives were considered ranging from becoming a profit-maker to dissolving the company.

On the latter point, the board concluded that SDC represented a good capability for which there is a continuing need and with which its customers were pleased. Also, they felt the SDC team was "worth more as a unit" than it would be spread throughout the industry.

On the question of becoming a profit-maker, the board decided that it should remain an independent not-for-profit as long as there is a need and this "continues to be an honorable existence."

The *ad hoc* committee report has worried aloud that "if the corporation is turned loose, the fact that the Government permits the action might place in jeopardy the capabilities of Mitre

System Development Corp. President Melahn. Firm was faced with alternatives ranging from converting to a profit-making concern to going out of business, but chose to remain non-profit as long as it "continued to be an honorable existence."

and Aerospace. If this is a portent of the future of all non-profits, industry may no longer desire to share its proprietary data with the sponsored corporations."

The report then admits the differing character of SDC and the firm's contention that it is not an Air Force-sponsored non-profit. The committee's final recommendation, concurred in by Gen. B. A. Schriever, AFSC commander, and Secretary of the Air Force Harold Brown, is that "Air Force relations with System Development Corporation should now be placed on a normal Air Force/contractor basis. There should be a public withdrawal of the Air Force policy statement of 1964, without prejudice to the corporation. There should be no special privileges or considerations regarding research planning or new business with SDC."

A sponsored monopoly—Melahn emphasizes "that this recognition of SDC's role as an independent non-profit organization does not mean that SDC will be any less concerned with continuing to serve the needs of our Air Force customers. Neither do I believe that it means that the Air Force is less interested in having SDC continue to serve its needs."

In fact, the 1964 policy statement on SDC has placed the company in a good position to compete for military business. That memo directed contracting with SDC on a task-by-task basis, taking into account "the benefits that derive from SDC's status as a non-profit, non-hardware producer, in terms of close working arrangements, objectivity and protection of sensitive information. The decisive factor, however, must be SDC's capabilities to perform the specific task at hand. Tasks that can be performed as well by industrial firms should be competed among them, if not performed in-house."

Thus, most of SDC's contracts with the Air Force are sole-source. Justification for these awards is expected to be valid even under the company's change in status. The only tasks Melahn feels the company will be ineligible for are small planning jobs the company has done for Electronic Systems Div. in the past.

Major military tasks being done by SDC that contributed to its $50 million Fiscal Year 1965 budget:

—Provision of operational, maintenance and training support for ADC in updating the SAGE computer programs and providing computerized system training to keep ADC in a state of emergency readiness ($18 million in FY '65).

—BUIC program ($6.5 million in FY '65).

—NORAD command operation center software and updating the

Pratt & Whitney Aircraft needs engineers with imagination, ingenuity, and initiative to work in a newly formed gas turbine research group, engaged in seeking advanced concepts in turbine cooling and turbine aerodynamics.

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A

NORAD space track programs ($4 million).

—System training programs for other Air Force commands and the Army, as well as military assistance countries ($4 million).

—Support of Space Systems Div./Aerospace Corp. through maintenance and operation of a computerized library of satellite trajectory information for operational research and for use in operational launch and in-orbit control by the Air Force Satellite Control Facility ($6.5 million).

SDC has also had contracts with the Navy, the Office of Civil Defense and ARPA, the Advanced Research Projects Agency. The ARPA contract is the experiment in developing time-sharing techniques.

In the civilian world—Already considerably experienced in the application of information processing to civilian needs, SDC has designed automatic information processing and retrieval systems for school districts in New York's Rockland County and for Quebec's Ministry of Education. It also has an extensive program covering the spectrum of computer-aided education.

In law enforcement, it has designed New York State's identification and intelligence system and a computer-based information system for the Los Angeles Police Dept.

SDC is a planning and technical support contractor for the Appalachian Regional Commission, part of the War on Poverty. It has also aided and advised the State of California and designed an information system for the Job Corps.

The company is engaged in several projects related to the development planning of a national information retrieval system. Having already studied the problem from the viewpoint of the Federal Council for Science and Technology, SDC is now working under a National Science Foundation contract to study the abstracting and indexing services performed by the national scientific and technical document handling system.

SDC's Melahn summarizes the company's position in these words, "it has a distinctive competence in information sciences and technologies provided by a large technical staff with extensive training and broad varied experience.

"Since its incorporation in 1956, SDC has played a key role in the significant developments in the information sciences and computer technology. These include pioneering efforts in the first real-time information systems, higher-order programming languages, simulation, computer time-sharing, natural language research and development of user-oriented systems." ■

NASA Considers Facsimile Camera

by Ron Barnhart

Boston—A facsimile camera originally designed for the *Ranger* program is getting serious NASA consideration for the *Surveyor* and *Apollo* Applications programs.

The camera, developed by the Aeronutronic Div., Philco Corp., is meant to be dropped—presently on the Moon and later on one or two of the near planets.

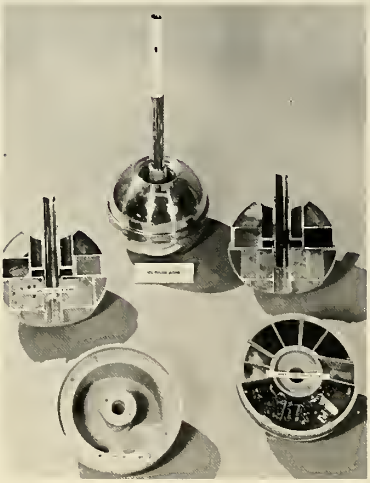
Details were revealed recently in the War Memorial Auditorium here by Dr. D. N. Tompkins, technical leader of the group that developed it. Speaking in a technical session at the National Telemetering Conference, Tompkins reported that tests have proved the camera's components can successfully withstand shocks of more than 4,000 g's at impacts up to 130 mph. Other tests, he said, have shown they can survive temperatures ranging from −250° F to +250° F, perform in vacuums down to 10^{-13} mm hg, and operate while exposed to the radiation encountered in deep space.

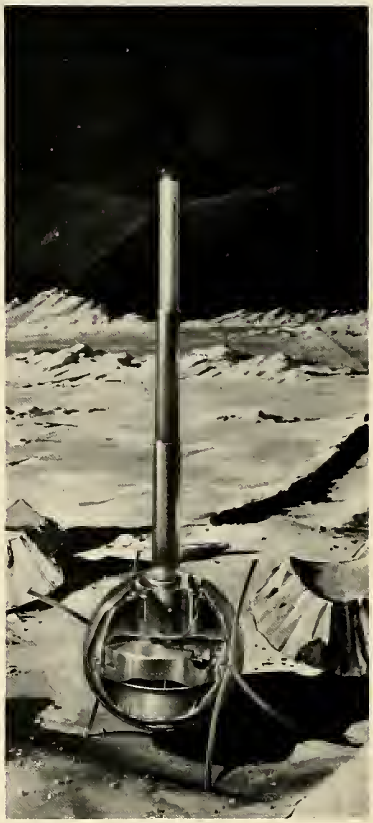
In addition to being able to take this licking, Tompkins claims the lunar facsimile camera can produce black-and-white photographs of the Moon's surface far superior to similar pictures obtained by other modes of video photography.

How it works—As described by Tompkins, the facsimile camera is a high-resolution electromechanical line scanner that is based on a unique concept in line scan imagery. It is selectively responsive, even under subdued lighting, to either visible or infrared wavelengths, or both. The camera provides a 360-degree picture of the visible surroundings from the near field to an unobscured horizon. A complete survey of its field of view may take less than a minute or as much as several hours, depending upon the requirements and constraints of the mission.

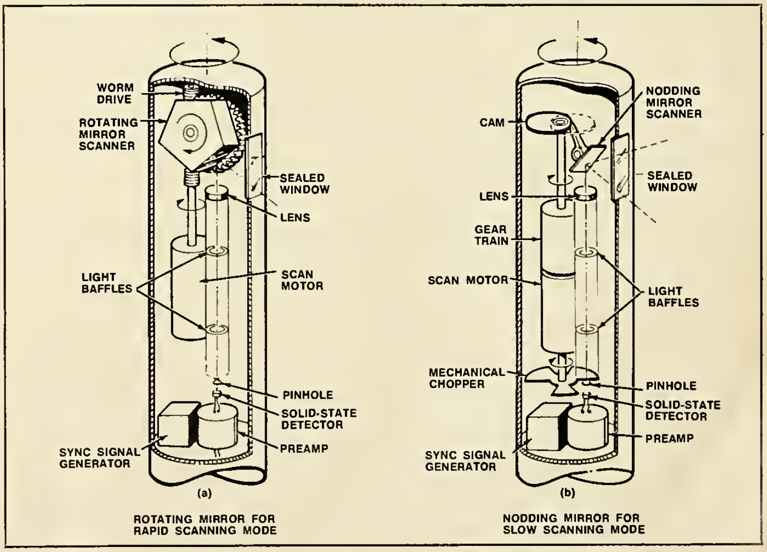
Its performance characteristics are based on the use of fixed, narrow-field-of-view, high-focal-ratio optics, which are placed in front of a quantum detector of large dynamic range and broad spectral response. The fixed-focus optics provide a distortion-free picture that is in focus from a few feet away to infinity. The scene surveyed appears similar to the view as it would be seen by the human eye.

The facsimile camera differs from





Above: *Components of lunar facsimile camera designed to survive landing impacts of 3,000 g's. NASA is considering the unit for possible use in Surveyor and Apollo Applications programs.* Right: *One-pound lunar facsimile camera is shown atop landed capsule in this artist's concept.* Below: *Schematics of Aeronutronic's camera show alternate modes for providing vertical scanning throughout panoramic view field. Unit functions as a high-resolution electromechanical line-scanning instrument.*


WORM DRIVE
ROTATING MIRROR SCANNER
SEALED WINDOW
LENS
LIGHT BAFFLES
SCAN MOTOR
PINHOLE
SOLID-STATE DETECTOR
PREAMP
SYNC SIGNAL GENERATOR
(a)
CAM
NODDING MIRROR SCANNER
SEALED WINDOW
LENS
GEAR TRAIN
SCAN MOTOR
LIGHT BAFFLES
MECHANICAL CHOPPER
PINHOLE
SOLID-STATE DETECTOR
PREAMP
SYNC SIGNAL GENERATOR
(b)

ROTATING MIRROR FOR RAPID SCANNING MODE

NODDING MIRROR FOR SLOW SCANNING MODE

the cathode-ray tubes used in most conventional video scanners. Instead of having an electron beam scan an image produced by a mirror, the facsimile camera directs its optics directly onto a delicate photoelectric cell. This, in turn, produces an electrical signal that is then transmitted directly to an Earth-based readout station where a playback device converts the received signal into an accurate reproduction of the detected information.

The light directed onto the photoelectric cell comes from a mechanical mirror arrangement that causes the mirror to bob up and down, taking a look at the ground beneath it and the sky overhead as it does so. At the same time, the entire mirror assembly spins at the end of its mast, affording the mirror a full 360-degree view of the landscape.

Simplicity stressed—Because of its electromechanical construction, the facsimile camera is simple and flexible, yet efficient in a large variety of missions. It can operate as a scientific instrument to provide both precise photogrammetric data and stable photometric calibration. Since scanning occurs in the object space, each image point corresponds to an axial object point. As a result, the facsimile picture is inherently distortion-free, and the resolution does not degrade at the picture edge but remains constant over the entire raster. This greatly simplifies photogrammetric measurements.

Furthermore, the continuous nature of the facsimile picture-taking operation results in high-resolution imagery in either a limited sector of the field of view or a complete panoramic sweep, without the need for mosaic reconstruction by overlapping successive picture frames.

Of the lunar facsimile cameras built to date by Aeronutronic, none has weighed more than 5 lbs., and 10 lbs. is viewed as a practical maximum. Exact size is a function of the sensitivity wanted from the camera. Imaging under subdued lighting conditions with a high signal-to-noise ratio dictates the speed of the optical system, which, together with the field of view, determines the dimensions of the scanning subsystem required. Higher signal-to-noise ratios and/or lower light-level detection are achieved at the expense of size, weight and power. All versions of the camera, however, are designed to operate from standard 28-volt power supplies without separate regulation for stability.

Development of the lunar facsimile camera is an outgrowth of earlier work done by Aeronutronics on a similar camera designed to operate in the environment of Mars. ■

Webb Sees Nuclear Rocket By 1975; $1 Billion Needed

Houston—NASA estimates that it will take an additional $1 billion to develop a nuclear-powered rocket stage, including $75 million in new facilities at Jackass Flats, Nev., Nuclear Rocket Development Center.

The space agency, as it has in the past two years, will push for a go-ahead for the rocket in the upcoming, Fiscal Year 1968, budget request. If the program is approved, it will mean that NASA and the Atomic Energy Commission (AEC) will have spent at least $1.8 billion on the program.

NASA Administrator James E. Webb made the estimate recently at a press conference in which he declared that NASA believes a nuclear rocket stage should be ready to fly by 1975.

In discussing NASA post-*Apollo* plans, Webb said, "I think next year will get a firm decision to move forward and not let these (Project *Apollo*) production lines . . . have an interruption because that's a very expensive thing to do. We will proceed with a nuclear rocket on the assumption that about 1975 we'll have a stage available to put on the *Saturn V*."

He added that "as soon as that decision is made, our plans to spend $75 million and double the capital plant at Jackass Flats will immediately be brought into play. . . .

"I would like to see it (nuclear rocket program) accelerated not only because I think the nuclear engine is important, but I think all the associated technologies will be worth twice as much as the engine itself," he continued.

"There is no other program here that will give us this total technological development—that involves the whole of nuclear technology—the whole materials research program and the coupling of that research with practical uses throughout American industry," he concluded.

NERVA has go-ahead—Funds for an advanced nuclear rocket engine, the *NERVA II*, have been requested in the FY '67 budget. It has already been approved by both the House of Representatives and the Senate.

Based on the Phoebus graphite nuclear reactor, the engine will provide 5,000 megawatts of power or a thrust of 250,000 lbs. Aerojet-General Corp., which developed its forerunner, the *NERVA* engine, is also expected to be selected to build the advanced version.

Harold Finger, manager of the joint NASA/AEC Space Nuclear Propulsion Office, told the press conference that in connection with development of the engine, "we also have design studies under way to determine what kinds of facilities, engine test stands, and stage test stands we would need in order to be able to develop the advanced engine and actually carry it to flight status."

He also said that NASA and the AEC have funds to do the design and preliminary component work on the engine and design work on the test stand.

Webb also said that the liquid-fueled *Saturn V* would fulfill all of NASA's needs in terms of a limited number of trips to the Moon as well as a manned fly-by of Mars. He declared, however, that a nuclear rocket stage would be needed if this country elects to make many flights to the Moon to build a permanent lunar base and also for any program designed to land on Mars. ■

Pageos Canister Assembly Checked Out at Goodyear

The canister assembly which will be used to orbit NASA's Pageos geodetic satellite later this year is examined by a technician at Goodyear Aerospace Corp. The 100-ft.-dia. inflatable satellite will be packed into the canister and released once orbit has been achieved. The satellite will be used to accurately determine relative locations of the Earth's land masses.

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An earlier version of the "133," the AN/GJQ-9, has been actively engaged on 12 aerospace programs, some for as long as 5 years. For example, it is checking out various avionic systems for supersonic fighters and bombers, arming and fusing systems for re-entry vehicles, guidance and control systems for space vehicles, and it is also used in laboratory research.

This extensive experience has proved the validity of a concept long pioneered by Bendix—that complex checkout programs can be served most effectively by a standard configuration that's easily adapted to any application.

Further development of this concept has produced the new "133" that offers even more advantages than its predecessor. Due to microcircuitry, it is half the size and weight, more reliable, and much easier to maintain. It is air transportable and can be mounted on a trailer or pedestal without design changes. Remote control stations, such as a portable cockpit display unit, can be used. For increased data handling, computer interfacing capabilities are built in. And for greater accuracy, it reads out test data in four digits instead of the usual two or three.

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THE Bendix CORPORATION

The Industry Week

Space Exhibit, Education Center Proposed

A new forum in which to acquaint the public with commercial "spinoff" from Space-Age technology has been proposed near the Kennedy Space Center, Cape Kennedy, Fla., by Holmes Troutman, Florida-based aerospace industry consultant. The Scientific Industrial Research Center, as Troutman envisions it, would provide areas for sophisticated working industry exhibits on a 10-year-lease basis, and would be seen by the millions of visitors touring KSC each year. The center would also make exhibit space available at no cost to colleges and to Florida and Federal Government agencies. It could be expanded to accommodate conventions.

Mergers and Acquisitions

Computer Sciences Corp., El Segundo, Calif., will acquire the assets of Roland F. Beers, Inc., Alexandria, Va., Beers provides geological, geophysical and engineering services to the Atomic Energy Commission. It will be operated as a unit of System Sciences Corp., a wholly owned subsidiary of Computer Sciences. . . . *Star-Glo Rubber Manufacturing, Inc., East Rutherford, N.J., has purchased Cresskill/Stillman Rubber Co., Englewood, N.J. Cresskill/Stillman specializes in molding elastomeric materials for the missile/space program and for military equipment in nuclear submarines, jet aircraft and ships.* . . . Elpac, Inc., Newport Beach, Calif., plans to acquire the assets of Acutech Industries, Inc., Venice, Calif., manufacturer of printed circuit boards for aerospace, military and commercial applications. . . . *Television Associates of Indiana, Michigan City, Ind., has moved its operations to Melpar, Inc.'s main facility in Falls Church, Va. Television Associates, a subsidiary of Melpar, provides telecommunication system design and consulting services.*

International

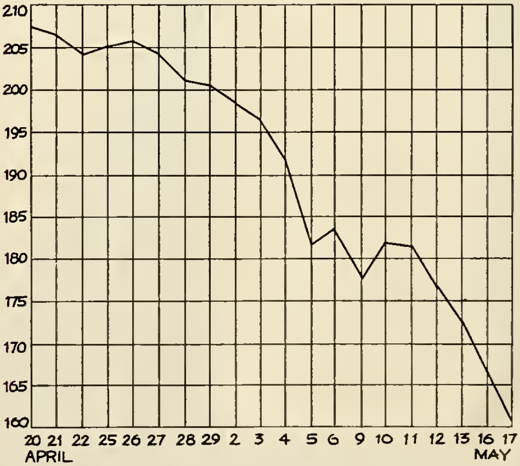
Philco Corp., Palo Alto, Calif., and Nord Aviation, Paris, France, have signed an agreement to jointly pursue research, development and manufacture of space vehicles and satellites for international programs. The agreement covers an initial period of six years. . . .*Texas Instruments Italia S.p.A., a subsidiary of Texas Instruments, Inc., Dallas, Tex., has dedicated a new electrical and thermal controls manufacturing plant in Aversa (Caserta), Italy.* . . . Information Handling (U.K.) Ltd. and a wholly owned subsidiary, Information Handling (Europe) Ltd., have been established as a joint venture of Information Handling Services, Inc., Englewood, Colo., and International Publishing Corp., London, England. IHS has also formed a joint company, Nippon VSMF, in Tokyo, Japan, with Mr. Motoo Shiina. The U.S. company recently demonstrated a new multi-lingual microfilm industrial communications network to simultaneously offer complete scientific and technical information to industrialized nations of the free world. The system is designed as a link between those who manufacture components and materials and those who use them. The joint-venture firms will market the information files. . . . *TRW, Inc., Redondo Beach, Calif., and Mitsubishi Electric Co., Japan, have established a team to design, construct, install, maintain and operate communication satellite ground stations. The team has been joined by Hawker-Siddeley Dynamics, Australia, and is now working on a proposal to be submitted to the Australian Government for a ground station near Sydney.*

Potpourri

By 1980, the fluidics industry will reach a billion-dollar market, an industry spokesman has predicted. According to Warren W. Johnston, general manager of Imperial-Eastman Corp.'s Fluidonics Div., Chicago, the billion-dollar figure "would be exclusive of an additional $100 million funded by the Federal Government and industry for research and development." Johnston also predicted that during the next two years, the fluidics industry would see circuit component costs reduced from $20 to $2 or less, an expansion of international activities, increased miniaturization and an increasing shift to sales of complete systems. . . . *NASA employment at Cape Kennedy is expected to increase by some 1,350 by July 1, according to Dr. Kurt H. Debus, director of the Kennedy Space Center. Most of the increased employment will be on the payrolls of support and stage contractors in the manned spaceflight area, Debus said. Total space center employment, including contractors, on April 25 was 16,850, not including construction workers.*

Missile/Space Stock Index

The Missile/Space Weighted Stock Index continued to plummet along with the general stock market, falling to 160 on May 17. While no development in the aerospace/defense field contributed to the depression of these stocks, lack of any large contracts or other significant stimulus made them especially vulnerable.



100 = CLOSING PRICES OF 19 REPRESENTATIVE AEROSPACE FIRMS DEC. 31, 1964
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Contracts

AIR FORCE

$3,115,200—**Martin, Co.,** Denver, Colo., segment of previously awarded contract for *Manned Orbiting Laboratory* requirements study.

$2,359,000—**Oakland Construction Co., Mark B. Garff Co., Ryherg and Garff Construction Co.,** Salt Lake City, Utah, a joint contract for construction of missile training facilities at the following bases: Malmstrom AFB, Mont., ($594,000); Ellsworth AFB, S.D., ($566,000); Whiteman AFB, Mo., ($578,000); Grand Forks AFB, N.D., ($621,000).

$1,500,000—**Douglas Aircraft Co., Inc.,** for conversion of *Thor* missiles to standard launch space boosters.

$107,650—**Avco Corp.,** Avco-Everett Research Laboratory, Everett, Mass., for research in plasma propulsion.

$89,250—**Lockheed Aircraft Corp.,** Lockheed Propulsion Co., Redlands, Calif., for Hydoc rocket motors.

$70,505—**Mithras, Inc.,** Cambridge, Mass., for development of theoretical models to explain radio frequency efforts associated with missile passage through the atmosphere.

$50,000—**Massachusetts Institute of Technology,** Cambridge, Mass., for research directed toward development of a method of objective forecasting of solar flare phenomena.

$30,466—**Texas Instruments, Inc.,** Dallas, Tex., for the Advanced Research Projects Agency Project Vela research.

$28,339—**General Dynamics Corp.,** Convair Div., San Diego, Calif., for continuation of research on ionizing fronts in plasma accelerators and generators.

ARMY

$2,025,000—**Aerojet-General Corp.,** Downey, Calif., fixed-price contract for metal parts for 2.75-in. rockets.

$2,025,000—**Hayes International Corp.,** Birmingham, Ala., fixed-price contract for metal parts for 2.75-in. rockets.

$343,630—**Perkin-Elmer Corp.,** Electro-Optical Div., Norwalk, Conn., for six months R&D for Project Glow.

121,840—**Radio Corp. of America,** Defense Electronic Products, Moorestown, N.J., to extend component verification effort in support of the *SAM-D* program.

$92,291—**Stanford Research Institute,** Menlo Park, Calif., for *SAM-D* air defense missile system studies.

$46,338—**Avco Corp.,** Avco-Everett Research Laboratory, Everett, Mass., contract modification for additional research effort in re-entry physics.

NAVY

1,008,000—**Aerojet-General Corp.,** Sacramento, Calif., for nitroplasticizer for *Polaris A-3* missiles.

$215,600—**Bowles Engineering Corp.,** Silver Spring, Md., for exploratory R&D—engineering effort to develop an all-fluid control system for torpedoes.

$96,505—**Vitro Corp. of America,** Vitro Laboratories, Silver Spring, Md., for R&D and management assistance in the field of vertical lift capability.

$61,438—**Sperry Gyroscope Co.,** Great Neck, N.Y., for services related to control systems for Trieste II and *Polaris.*

NASA

$2,300,000—**Dynatronics, Inc.,** Orlando, Fla., fixed-price contract to provide pulse code modulated (PCM) telemetry decommutator systems for Project *Apollo* communications.

$708,519—**United Aircraft Corp.,** Pratt & Whitney Aircraft Div., West Palm Beach, Fla., from Marshall Space Flight Center for design study of an engine system for upper stages of the uprated *Saturn* vehicle.

$650,000—**Ampex Corp.,** Redwood City, Calif., for magnetic recording tape to be used in processing data received from NASA's world-wide space tracking stations.

$292,241—**Lockheed Aircraft Corp.,** Sunnyvale, Calif., contract modification from Marshall Space Flight Center for study of modular nuclear vehicles technology problems and safety systems.

$232,000—**Honeywell, Inc.,** New York City, for a study to define possible experiments from space for gathering needed information about the Earth's horizon.

$206,857—**Lockheed Aircraft Corp.,** Lockheed Missile and Space Co., Palo Alto, Calif., from Headquarters for a rocket study of X-rays from the nonflaring Sun.

$200,000—**Philco Corp.,** Palo Alto, Calif., from Ames Research Center for research, design and development effort for lunar surface magnetometer experiment.

$180,000—**Stanford University,** Stanford, Calif., for investigations, theoretical and experimental analyses for a zero-g satellite development and Schiff gyro test of general theory of relativity.

$103,051—**University of Tennessee,** Knoxville, Tenn., for theoretical and experimental very-high-resolution spectroscopic studies of line shapes of atmospheric gases and of absorption bands of inorganic solids.

$100,000—**Stanford University,** Stanford, Calif., for theoretical and experimental investigations of collective microwave phenomena in solids.

$90,000—**New York University,** New York City, for theoretical investigations in the field of molecular quantum mechanics and transport properties of diatomic molecules.

$86,202—**Graduate Research Center of the Southwest,** Dallas, Tex., to expand the processing and interpretation of *Pioneer* data.

$85,000—**University of Virginia,** Charlottesville, Va., for research in the field of molecular collision phenomena using molecular beam techniques.

$78,113—**Florida State University,** Tallahassee, Fla., for a study of polarization of the decameter-wave radiation from Jupiter, with particular emphasis on the correlation between Jupiter and solar activity.

$70,810—**Avco Corp.,** Avco Everett Research Laboratory, Everett, Mass., from Headquarters for investigation of magnetospheric physics.

$69,665—**Northwestern University,** Evanston, Ill., for optical study and analysis of transient lunar phenomena.

$65,000—**University of Texas,** Houston, Tex., to continue the reduction of astronauts' clinical history data for use on computers.

$59,742—**Flight Safety Foundation, Inc.,** New York City, for analysis and testing of aircraft seats.

$57,200—**Stanford University,** Stanford, Calif., for a summer program in systems design engineering.

$51,366—**University of Colorado,** Boulder, Colo., to continue the investigation of the solar ultraviolet radiation.

$50,185—**University of Southern California,** Los Angeles, for exploratory and developmental study for a southern California regional dissemination center for technology utilization.

$49,060—**Massachusetts Institute of Technology,** Cambridge, Mass., for studies on the relationship between crystalline structure and superconductivity.

$43,000—**University of North Carolina,** Chapel Hill, N.C., for study and assessment of community health factors near major aerospace installations.

$29,272—**University of California,** Los Angeles, for investigation of spacecraft rotational dynamics and control.

$20,000—**Northrop Corp.,** Norair Div., Hawthorne, Calif., from Marshall Space Flight Center for study of aerodynamic properties of engine exhaust plumes.

COMMUNICATIONS SATELLITE CORP.

$441,412—**Nippon Electric Co., Ltd.,** Tokyo, Japan, for multiplex subsystem equipment for Comsat's Earth stations at Paumalu, Oahu, Hawaii, and Brewster Flat, Wash.

INDUSTRY

$2,800,000—**Allied Engineering Co.,** South Gate, Calif., and **Friendswood Development Co.,** formerly **Del E. Wehh Corp.,** Houston, Tex., in a joint venture from **Boeing Co..** Seattle, for modification of 150 *Minuteman* intercontinental ballistic missile sites at Whiteman AFB, Mo.

$250,000—**Consolidated Controls Corp.,** El Segundo, Calif., from **Boeing Co.,** Seattle, for *Minuteman* intercontinental ballistic missile stage-separation switches.

$95,000—**Atlas Chemical Industries, Inc.,** Wilmington, Del., from **Boeing Co.,** Seattle, for work in connection with the advanced *Minuteman* intercontinental ballistic missile program.

$30,000—**Electro-Tech Corp.,** Virginia Div., Blacksburg, Va., from **Philco Corp.,** Aeronutronic Div., Newport Beach, Calif., an initial contract to design and produce a number of highly discrete slip ring assemblies for the U.S. Army Missile Command's *Chaparral* missile system.

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- Armor and Armament Systems Specialists to determine materials requirements and ballistic protection effectiveness, and to concept, design and integrate tactical weapon systems for advanced combat vehicles.
- Computer Simulation Specialists to conduct tactical systems simulation studies of ground combat vehicles.

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New Product of the Week: Loop Discriminator

A modular, phase-lock loop discriminator, for use in telemetry applications where a particular subcarrier signal is to be separated from an FM multiplex signal and later demodulated by phase-lock-loop detection, has been introduced by Defense Electronics, Inc.

Model SCD-1 features true locked loop performance for deviation up to ±40% through use of a ±180-degree phase detector. Phase linearity of the active element bandpass filter is better than 1%. Filter design includes all standard IRIG channels, AIA constant bandwidth channels, plus special channels to 300 kc.

Use of an active element input filter allows selection of various input ranges, with 2.0 mv rms as a minimum allowable input level. Working dynamic range for any selected input is 60 db. Input impedance is 100 k minimum. The input is truly isolated to allow selective grounding of input and output. The tape speed compensation is standard and the compensation results in a minimum of 30-db improvement ratios for speed variations of ±3%.

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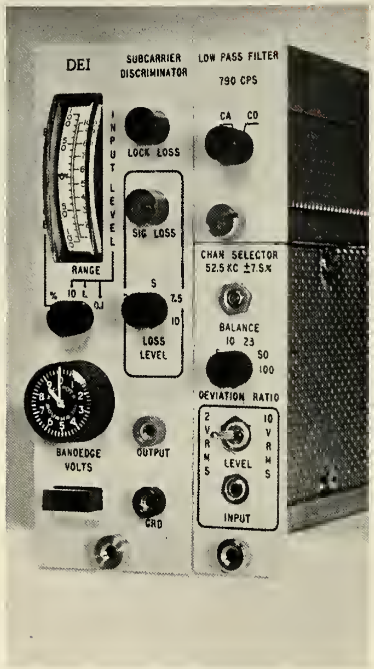
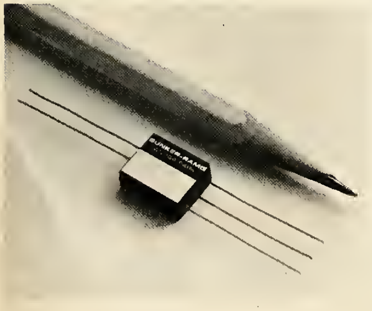


Voltage Regulator

A lightweight, microminiature, all-solid-state voltage regulator adaptable to aerospace applications has been developed by Bunker-Ramo Corp.

Model BR-801 has a regulated d-c output range of from 10 to 25v and output varies 15mv with 10-v input variation. The regulator compares the output voltage to a temperature-compensated zener reference voltage and provides regulating current to a series-regulated transistor at a rate greater than 10 microamps per millivolt of error. The instrument can be used to provide up to 75 milliamps of load current with a single power transistor.



Absolute maximum ratings of the regulator are: storage temperature, −65° to 200°C; operating temperature, −55° to 85°C; input d-c voltage, 40v.

Circle No. 152 on Subscriber Service Card

Multichannel Oscilloscope

A large-screen, multichannel display oscilloscope that permits display and resolution of frequency response curves and can be used in conjunction with almost any frequency sweep generator has been developed by Texscan Corp.

The Model DU-17 features two high-sensitivity Y amplifiers and one medium-sensitivity Y amplifier, which permits simultaneous display of three frequency response curves. Both amplifiers are dc-coupled so that narrow band measurements can be carried out at slow sweep speeds. A polarity reversing switch in each input channel adapts the instrument to RF probes with either positive or negative diode outputs.

The instrument includes an internal frequency marker, which enables the frequency marker pulses of the frequency-sweep generator to be displayed as vertical frequency marker lines. These extend the full height of the screen and facilitate the determination of frequencies when filters with steeply rising frequency response curves have to be measured.

Circle No. 153 on Subscriber Service Card

Metal Classifier

A crack detector/classifier for detection of flaws in materials and classification of physical properties has been announced by Magnaflux Corp.

The Magnatest ED-510 features variable frequency eddy current circuitry with sensitive probe and thru-coil circuits to provide a desired, measurable signal and simultaneously compensate for any spurious signals. An adjustable compensator reduces irrelevant signals caused by surface roughness and enables the unit to measure thickness of conductive and non-conductive coatings and non-magnetic sheet and foil.

The instrument may be operated manually or mechanized, using automatic feeders and sorting systems and/or external signaling or marking devices.

Circle No. 154 on Subscriber Service Card

Temperature Controller

A platinum resistance thermometer/temperature controller that simultaneously measures and controls temperature over a range of −192° to 1,000°C is being marketed by Applied Research Corp.

Model PT-2 consists of a manually operated analog computer that solves the quadratic equation for the temperature-versus-resistance relationship for platinum. Conversion of the resistance of a platinum sensor into a direct reading of temperature is accomplished by manually balancing a modified Kelvin bridge. This is done by means of five decade dials and a temperature deviation meter on the front panel. In its most sensitive range, the meter reads 0.01°C full scale, which results in a resolution of better than ±0.0005°C.

For temperature control, expanded scale measurements or recording, or high/low alarm, a signal proportional to the difference between the temperature set on the dials and the actual sensed temperature is continuously available. Multiple points can be monitored by

means of multipoint sensors and a scanner. The instrument can be calibrated to track the sensor to within ±0.01 °C for the range of 0 to 1,000°C.

Circle No. 155 on Subscriber Service Card

Strip Chart Recorder

A strip chart recorder in which recorded chart paper may be pulled out for review and then automatically re-rolled onto the take-up mechanism has been announced by Nesco Instruments Div. of Datapulse, Inc.

Model 210 uses a transistorized amplifier. Sensitivity of 1 mv to 10v full span in 9 ranges is featured, together with ±0.5% accuracy and less than 0.5-second full-span response. Capillary pen system with gimbal-mounted ink cartridge allows operation with the recorder in a vertical or horizontal position. The unit may be bench-, wall-, or panel-mounted.

Chart width is 5 in. Zero may be positioned at any point on the chart or up to ±50% off the chart by panel control. The solid-state amplifier uses epitaxial planar silicon transistors for low noise and stable operation from 0 to 50°C. Precision tuned line frequency notch filter minimizes response to longitudinal transverse common-mode signals.

Circle No. 156 on Subscriber Service Card

Display System

A unit that displays changing information from up to 128 data channels in bar-graph form on a compact 17-in. CRT has been announced by Telemetrics Div., Technical Measurement Corp.

Although up to 128 data channels can be simultaneously measured or compared, the Model 650 display system can hold data on 256 channels in an internal core memory. Individual switches permit any channel display to be intensified as desired. Data channels are displayed on a single oscilloscope with relative magnitude of each channel instantly visible. Calibration circuits automatically generate calibration markers at intervals of 25% of full scale. A front panel switch permits checking the calibration values stored in memory against an internal standard.

Data displayed may be decommutated telemetry data, computer outputs, multi-channel industrial instrumentation, digital output from a spectrum analyzer, medical instrumentation, or any source of continuously uprated data.

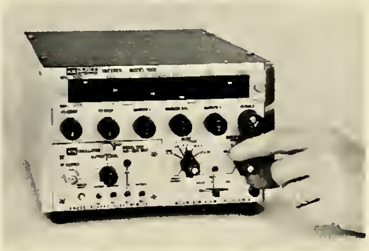
Circle No. 157 on Subscriber Service Card

Microwave Sweeper

A completely solid-state wide-range microwave sweep instrument has been announced by Kruse-Storke Electronics.

Model 5000 has self-contained power supplies that furnish swept voltage and current for operating several plug-in types. Currently available are four plug-in oscillators covering a range of 0.25 to 2.4 GHz.

Features are calibrated frequency vernier, stable AM square wave frequency, direct phase lock connection and narrow spectrum free of spurious responses. Wide and symmetrical narrow sweeps are provided with calibrated frequency markers on both. Internal PIN leveling is provided, using an external RF detector. Semiconductor oscillator circuits are employed, which reduces size of the instrument.



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Precision Power Oscillator

A precision power oscillator that eliminates the need for an external power amplifier has been announced by Optimation, Inc.

Model AC15 is a stable power source for system component testing or for calibrating a-c meters to 150v. It delivers 15VA from 0.1 Hz to 20 KHz with less than 0.05% distortion and amplitude stability within 10 ppm. Output voltage range is from 0 to 150v rms.

Frequencies are set and read directly by means of four-digit selector switches with a moving decimal point, plus vernier. Frequency accuracy is 0.1%. Line and load regulation are less than 0.01% and internal resistance is adjustable through zero.

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ROMEC LUBE AND SCAVENGE PUMPS

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Among the many Romec products specified for spacecraft performance are Models RR16920A and RR17580 Lube and Scavenge Pumps used for the gear box of the Titan Rocket.

These positive-displacement, rotary, sliding vane-type pumps were selected for light weight, small size and relatively high performance. The over-all length of each pump is 9⅜ in. and each weighs only 2.3 lb.

On each pump the splined-coupling direct drive operates three in-line vane-type elements, rated at 3720 rpm. Capacity of the lube element is 1.25 gpm with MIL-L-7808 oil at 100°F. Output of each of the two scavenge elements is 1.0 gpm. With 30 psig discharge, the power required is only 0.15 hp. Flow remains constant between sea level and 42,000 ft. Performance includes operation with oil temperature range of −65°F to +350°F and ambient temperatures of −65°F to +650°F.

These performance characteristics reflect the engineering skill and manufacturing care given all Romec products for aerospace, ordnance and naval applications.

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THE ROMEC FACILITY of LSI is the only major pump manufacturer in continuous production of all four basic pump structures... gear, vane, centrifugal and piston. Other fluid handling systems such as heat transfer units, quick disconnect couplings, hydraulic power packages, pressurization units, pressure switches, valves, and actuators are designed, qualified, and produced by Romec for aerospace, ordnance, ground, and marine vehicles. Unusual design problems, low cost, and reliability are Romec specialties. Write for literature.

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Names in the News

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BOOTH

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SCHURZ

LE FEVRE

Lloyd L. Kelly: Elected executive vice president and general manager of General Precision, Inc. He has been president of the Link Group of the company since 1963. He started with the company in 1945.

Charles J. Seeley: Appointed director of materiel for Page Communications Engineers, Inc. He will be responsible for policies relating to procurement, logistics support, quality assurance and reliability for the Washington, D.C., office.

John G. Booth: Joined Monitor Systems, Inc., as vice president of manufacturing. The company specializes in ground data systems for the aerospace industry, with emphasis on pulse code modulation telemetry.

Raymond L. Bisplinghoff: Elected a director of Allied Research Associates, Inc. He will also serve as chief technical consultant. He is president of the American Institute of Aeronautics and Astronautics.

Daniel H. Schurz: Received for Bendix Systems Div. the Silver Anvil Award for media relations of the Public Relations Society of America. He is director of public relations for the division and provided the impetus for the "Directory of Public Information Contacts in Washington," for which Bendix won the award.

E. J. LeFevre: Appointed a vice president of General Dynamics Corp. He directs activities of the corporation's field offices in 16 locations in the United States.

John P. Lawler: Elected a vice president of Texaco Experiment, Inc., a subsidiary of Texaco, Inc. He will be in charge of marketing activities, including field representatives and research and development liaison necessary to the marketing program.

George J. Meyers, Jr.: Elected treasurer of Nuclide Corp. He is also general manager of the corporation. He has been with the firm since 1963. He was with General Electric Co. for 17 years, where he was involved in the development of America's first jet engines.

Otto J. Riss: Appointed vice president of operations, Home Products Div., Packard Bell Electronics Corp. For the past four years, he was assistant general manager of Bendix Corp.'s Aerospace Div.

Robert E. Ramsey: Named vice president of operations of Continental Electronics Manufacturing Co. and Continental Electronics Systems, Inc., subsidiaries of LTV Electrosystems, Inc. He has been with the company since 1958.

Anthony F. DiPentima: Appointed as vice president, intelligence systems department, of CBS Laboratories. Before joining CBS Laboratories, he was chief of the reconnaissance data extraction branch of the Air Force's Rome Air Development Center, Rome AFB, N.Y.

Richard A. Robinson: Appointed president of Gulton International, a subsidiary of Gulton Industries, Inc. He will have responsibility for integrating the parent company's international marketing effort and coordinating the technologies of Gulton's various divisions and subsidiaries to further penetrate the Far Eastern markets and other overseas areas.

Henry Comeau: Appointed vice president of sales of the Deutsch Co., Electronic Components Div. He has been active in the aircraft, aerospace and electronics industries since 1935. He has been with the company since 1948.

William W. Evans: Appointed a vice president of the Carborundum Co. He is the director of marketing at the company and a member of its policy group. **Robert C. Straka, Jr.,** was also named a vice president of the company. Straka is the general manager of the company's refractories and electronics division.

Dr. Howard C. Merchant: Joined Physics International Co. as head of the materials and structures section of the firm's vulnerability division. He will be in charge of a re-entry vehicle impact program at the company and will supervise the company's research in the area of mechanical response of systems and structures, material response to radiation or blast, and vibration of structures.

William A. Golomski: Elected president of the American Society for Quality Control. He is assistant to the executive vice president, Jos. Schlitz Brewing Co.

James Payton: Named president of SDS Data Systems. He will continue as director of the company and will be responsible for digital systems work.

Joseph DiMarzo: Elected vice president for finance and administration for Technical Operations, Inc. **Richard D. Coons** was elected a corporate vice president of the company.

Dr. Alfred H. Keil: Appointed professor and head of the department of naval architecture and marine engineering at the Massachusetts Institute of Technology. He was an active member of the advisory committee for the planning of *Polaris* long-range research and development.

Col. N. A. Lord: Named to command the Canaveral District of the U.S. Army Corps of Engineers. He has been serving as deputy district engineer for Kennedy Space Center construction.

Harold E. Brown: Appointed vice president and director of engineering and marketing of Sunbeam Electronics, a subsidiary of Sunbeam Corp. Prior to joining the company, he was with General Electric Co., where he was manager of marketing of advanced product planning operation for the Electronics Components Div.

Beverly H. Warren: Named vice president of Avco Corp. He is vice president and general manager of Avco Lycoming Div. He joined the company in 1960 as director of its operational missiles subdivision after 25 years in the Air Force.

Robert O. Fickes: Elected chairman of the board of directors of Philco Corp. He will continue to serve as president and chief executive officer of Philco. He succeeds **Irving A. Duffy,** who is retiring.

William Olbrich: Appointed vice president and general manager of G. S. Marshall Co., a division of Marshall Industries. He was formerly director of marketing for the company.

Nathaniel T. Holzer: Appointed vice president and director of marketing for Dynamic System Electronics. He will also serve as a member of the board of directors.

Robert M. Silver: Appointed procurement and contract administration manager at the central operation of Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc. He is responsible for the contract and subcontract administration and purchasing departments.

missiles and rockets

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When and Where

MAY

28th Annual Meeting and News Conference, sponsored by the Aviation/Space Writers Association, New York Hilton Hotel, New York City, May 23-26.

Seventh National Chemical & Petroleum Instrumentation Symposium, sponsored by the Instrument Society of America, Sheraton-Palace Hotel, San Francisco, May 23-25.

12th Annual Meeting of the American Astronautical Society, Disneyland Hotel, Anaheim, Calif., May 23-25.

Superconductivity in Science and Technology Conference, sponsored by the University of Chicago, Chicago, May 23-24.

Air Force Aero Propulsion Laboratory-Southwest Research Institute Turbine Engine Lubrication Conference, Granada Hotel, San Antonio, Tex., May 23-25.

Symposium on Methods of Materials Selection, sponsored by the American Institute of Metallurgical Engineers, American Society for Metals and the National Association of Corrosion Engineers, University of Florida, Gainesville, Fla., May 23-25.

15th Annual Corrosion Symposium, sponsored by the U.S. Atomic Energy Commission, Oak Ridge National Laboratory, Oak Ridge, Tenn., May 23-25.

Sixth European Symposium on Space Technology, Pavilion Theater, Brighton, England, May 23-25.

17th Annual Institute Conference & Convention, sponsored by the American Institute of Industrial Engineers, Inc., Sheraton-Palace Hotel, San Francisco, May 26-28.

Photography as a Tool for the Engineer, sponsored by the Washington, D.C. chapter of the Society of Photographic Scientists and Engineers, Marriott Twin Bridges Motel, Washington, D.C., May 26-27.

Society of Plastics Engineers Regional Technology Conference, Military Park, Newark, N.J., May 26-27.

International Congress on the Sea, sponsored by the Thermal and Climatic Federation, Treboul-Douarnenez, France, May 28-June 6.

Second International Oceanographic Congress, Moscow, Russia, May 30-June 9.

JUNE

20th Annual Technical Conference & Exhibit, sponsored by the American Society for Quality Control, Statler Hilton Hotel, New York City, June 1-3.

New England Regional Metalworking Conference and Exposition, sponsored by the American Society for Metals, War Memorial Auditorium, Boston, June 2-4.

Second International Aircraft, Airport Equipment and Space Exhibition, sponsored by the Italian Federation Aerospace Industries, Turin, Italy, June 4-12.

Lubrication Symposium and a Symposium on Friction and Lubrication in Metal Processing, sponsored by the American Society of Mechanical Engineers, Royal Orleans Hotel, New Orleans, June 5-9.

Design & Construction of Large Steerable Aerials for Satellite Communication, Radio Astronomy & Radar, sponsored by the Institute of Electrical and Electronics Engineers, Savoy Place, London, England, June 6-8.

11th National Plastic Exposition, sponsored by the Society of the Plastic Industry, Inc., New York Coliseum, New York City, June 6-10.

20th Annual Convention of the Armed Force Communications and Electronics Association, Sheraton-Park Hotel, Washington, D.C., June 7-9.

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A Time for Decisions

IT APPEARS WE ARE IN for another round of international nonsense.

President Johnson's proposal for a treaty to cover man's exploration of the Moon and other heavenly bodies, suggested last month by the *New York Times* and long ago by others, has not too surprisingly been hailed by the *Times* as coming "none too soon."

The *Times,* of course, greets each space accomplishment by either side as an opportunity to cry out for international cooperation. All well and good, but that eminent publication thus far has failed to discover anyone with whom we can cooperate.

The Russians, being a somewhat practical breed, decline to cooperate on other than a minor level. Even the West European nations have displayed remarkably little interest in joint programs with the U.S. Following President Johnson's proposal to West Germany's Chancellor Erhard of greater international cooperation in space, it was announced that Administrator James E. Webb of the National Aeronautics and Space Administration would make a trip to Europe to investigate the matter.

NASA advance scouts then went off to Europe to sound out possible proposals for discussion. They came back pretty much empty-handed. The Europeans are more interested at the moment in just what they will do on their own—and developments at the recent Paris meeting of the European Launcher Development Organization (ELDO) indicate considerable uncertainty even in that regard.

It does not appear that Mr. Webb's European trip will come off very soon.

Basically, the President's proposal of a Moon treaty is sound enough. But the fact that it was thrust forward with all the weight of a White House pronouncement raises the question of why it was brought up just at this time. There is already a United Nations resolution that covers much the same ground. With this in effect, certainly there are other aspects of the space race more deserving of White House attention than a Moon treaty.

With no one showing much interest in international cooperation, the President's proposal has all the earmarks of a runner suggesting to his opponent in the stretch, "If you beat me, let's share the cup."

What should be of much more interest to the White House is the pressing need for a decision on what the U.S. is to do next with the technological base built up in the *Apollo* program. The capability developed at so much expense already is beginning to erode as design teams are laid off. At Boeing, Douglas, Chrysler, North American Aviation, and others, the end of the line on production for *Apollo* is now in sight.

The billions of dollars spent in the lunar program have elevated U.S. science and technology to new heights. This advanced technology is the nation's prime asset today. If its importance is not always seen clearly in this country, it certainly is apparent to the Europeans. That is precisely the reason why they are more interested in developing their own projects than in cooperating with the U.S. They realize that failure to keep pace in the new technologies will inevitably reduce them to an inferior status.

FOR THE SAME REASON, the U.S. must continue to press ahead with its technology. Decision on a follow-on to the manned lunar landing is what is urgently needed within the Administration. It is this, rather than a Moon treaty, which can come "none too soon."

NASA, however, is showing a strange reluctance to declare itself on a follow-on project. For the space agency to take the position that it exists merely to provide technical competence—and not advice—is an abdication of its responsibility. The NASA administrator should act as the President's adviser on space just as the Secretary of Defense does in the military field.

NASA is qualified to lay before the President, the Space Council and the Congress its views on the follow-on program. If this were done, it might help firm up the decision. Then a start could be made. Failure at the space agency to reach an internal accord will result in continued vacillation over half a dozen projects.

The decision also would make it clear to the Europeans what options remain to them. We personally would favor a Martian fly-by as an up-rated goal of the U.S. space program. This not only can be accomplished with *Apollo* hardware but, as we have noted (M/R, May 2, p. 46), it would soften the impact of a Soviet victory in the lunar race. A European space project then could be oriented to a manned lunar base. This would provide the strong challenge necessary to advance European technology, which already is competent to start work toward such an objective. The cooperative aspect could fall in the area of U.S., and possibly Soviet, logistic support with launch vehicles and spacecraft..

But without a firm follow-on project to *Apollo,* we will continue to wallow in foggy and ill-defined internationalism—as exemplified by the Moon treaty proposal. In fact, the clearest voice lately on the subject has been that of Soviet physicist Peter Kapitsa, who declares himself against close cooperation between the Soviet Union and the United States in space. He says competition is good, stimulates research and produces a variety of solutions to different problems. So it does.

William J. Coughlin

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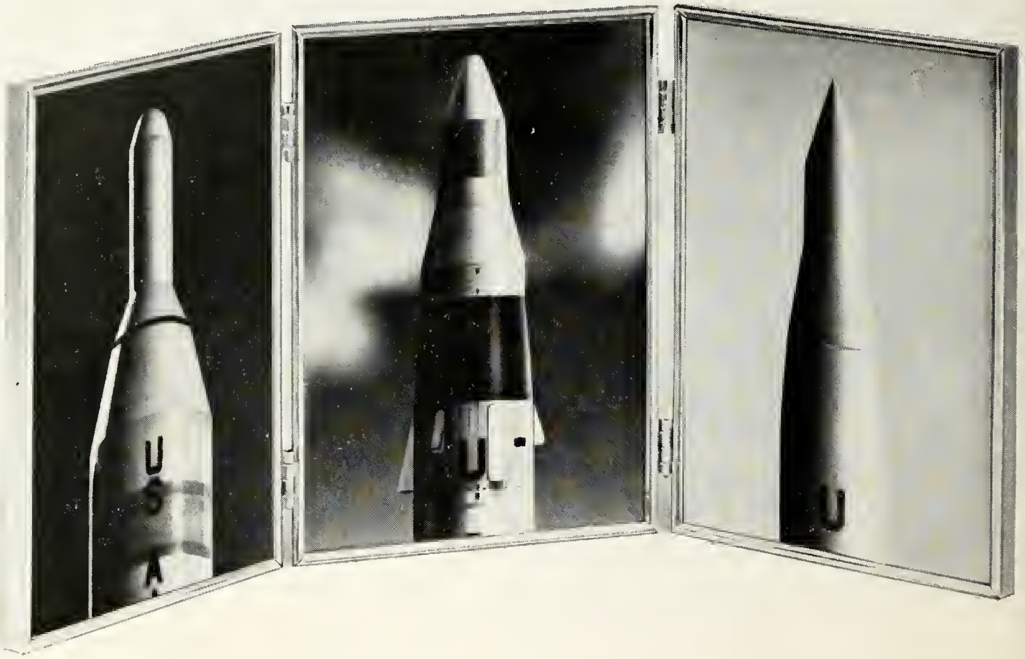

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MAY 30, 1966

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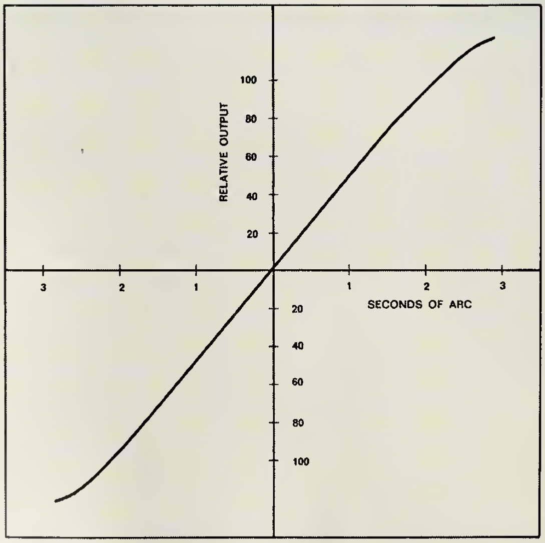

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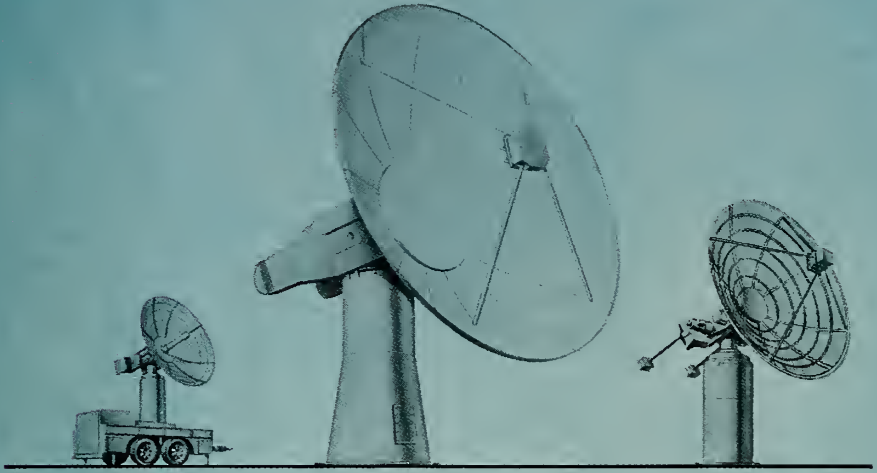

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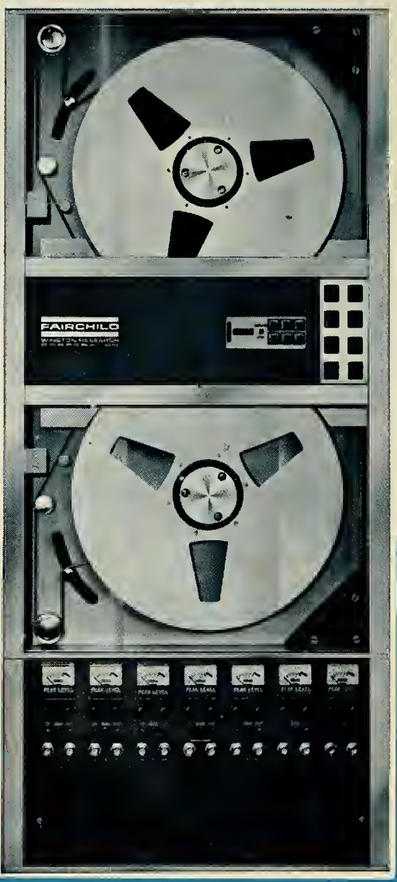

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Volume 18, Number 22 May 30, 1966

missiles and rockets

THE WEEKLY OF ADVANCED TECHNOLOGY

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SPECIAL REPORT: MILITARY SPACE

Compiled under the direction of Military Editor Michael Getler

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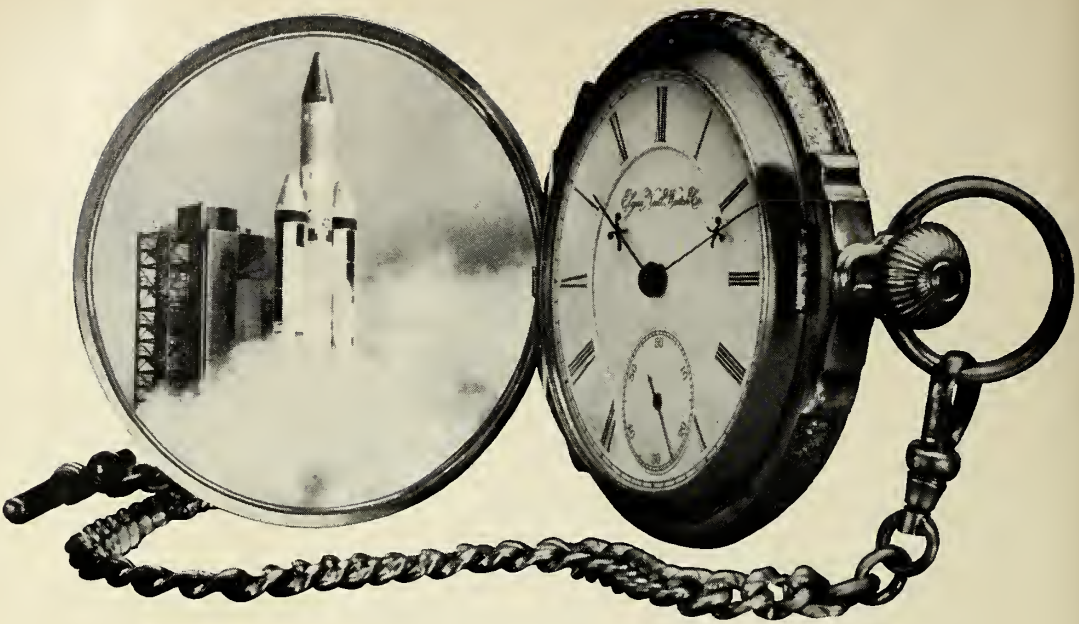
THE COVER

An Air Force Titan III-C launch vehicle, minus payload, is moved by two 800-hp locomotives along rails to the launch pad in a checkout of the Integrate-Transfer-Launch complex at Cape Kennedy. The Titan III, the workhorse of the military launch vehicles, will lift the Manned Orbiting Laboratory. M/R's special report on military space begins on p. 24.

50,400 copies this issue



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DEC. 1962: Test-firing of single solid propellant rocket composed of 12 segments.

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FEB. 1963: First successful test-firing of a one-segment 120-inch diameter rocket.

JULY 1963: Test-firing of one-million-pound thrust, five-segment, 120-inch diameter solid rocket, then the world's largest.

OCT. 1963: Announced development of new fast-burning solid propellant capable of accelerating a rocket to eight times the speed of sound in less than one second.

MAY 1964: Started development of small solid-propellant staging rockets to separate Titan III-C booster from the core vehicle.

DEC. 1964: Shipped to Cape Kennedy the largest solid rockets ever transported by train.

APR. 1965: Completed 28-month ground test phase of 120-inch-diameter motor development program with 14th full-scale static test-firing of a five-segment rocket.

JUN. 1965: Perfect performance in first test flight for a pair of UTC booster rockets developing nearly 2.5 million pounds of thrust at lift-off.

AUG. 1965: Successful flight of high-performance, top-stage solid rocket, increasing polar orbit capability of Scout vehicle by 25%.

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Letters

Apollo Antennas

To the Editor:

In the article "Firm Seeks Bigger Beryllium Market" (M/R, April 11, p. 22) you state in two places that Solar Division of International Harvester Co. is building the antennas for the *Apollo* spacecraft (Command Module) and the Lunar Excursion Module.

I would like to set the record straight.

Solar is building the *reflectors* for the S-band steerable communications antennas for the *Apollo* CSM and the LEM under contract to Dalmo Victor, a Textron division. Dalmo Victor is building the S-band steerable communications *antennas* for the LEM under contract to RCA, Aerospace Systems Division, and for the CSM under contract to North American Aviation, Inc., Space & Information Systems Division.

John C. Stevenson
Information Services Director
Dalmo Victor Company
Belmont, Calif.

More About Comprise

To the Editor:

This letter refers to the correspondence concerning the use of the word "comprise" (M/R, May 2, p. 32; May 16, p. 6).

Fowler, in *Modern English Usage*, 4th Printing (1950), makes the rather telling point in his discussion of "include, comprise" when he states that:

"As used in the newspapers, these may be called a pair of *working & stylish words*. The one used in ordinary life is *include*; the inferior kind of journalist therefore likes to impress his readers with *comprise*. . . ."

To be fair, he then goes into a technical discussion, which indicates that if you must use *comprise*, then your usage was technically correct. However, in his discussion of Working & Stylish Words, he points out that the use of such words is "like an escaped canary among the sparrows" and that instead of "improving (your) style, makes it stuffy, or pretentious, or incongruous." I also think you will agree that Fowler, unlike Partridge, Strunk and White, may be followed consistently.

Michael A. Duggan
Bethesda, Md.

To the Editor:

Your answer to the letter from "a very junior tech editor," chiding M/R for imprecise technical English (re/*comprise*), sounds suspiciously like the bleat of a petulant child. The suspicion is that the letter was published to give "Ed." an opportunity to throw up a bit of one-upmanship. As is so often the result in ego-involved tirades, poor "Ed." sounded at best a sour note.

A few opinions on the matter: (1) The intent of Mr. Braly's letter, in which he asked forgiveness for seeming pedantic, seemed to have something to do with a goal of more precise technical English, a goal with which M/R should surely desire to be associated. (2) "Ed." seems to share the illiterate's opinion that the dictionary, by listing all definitions more or less commonly used, gives permission to use any and all of them; it may seem more intelligent to recognize that the most commonly used definition (rather than "the last of these meanings") is to be preferred, even that a word might be avoided because of potential ambiguity (or even trivial arguments).

"Ed." should have his knuckles rapped for his petulance, as evidenced by the last sentence of his answer: "M/R tries to use English properly, and in this case has not misused it." I suggest "Ed." look up the word *case* in any book on writing (for example, *Perrin's Writer's Guide and Index to English*, in which he says: "Some of the commonest bits of deadwood in writing are various locutions with the word *case*").

Oliver K. Malcolmson
Cubic Corporation

Jogging Gemini's Memory

To the Editor:

Thank you for the very excellent reporting on the tape memory unit to be utilized in the *GT-9* test. As you know, it was used effectively on *GT-8* to load the re-entry program which enabled the astronauts to control their descent to the desired target area.

I would like to bring to your attention the fact that the *Gemini* computer was provided with a non-destructive core memory of 12,288 13-bit words and not with the drum as stated in your May 16 article. Confusion may have arisen over the fact that we do have several computer configurations where the central memory would be core and the auxiliary memory would utilize either a drum or tape.

Thank you again for the very fine article, and the overall editorial and article content you have maintained.

Arthur E. Cooper
Vice President
General Manager
Federal Systems Div.
IBM Corp.

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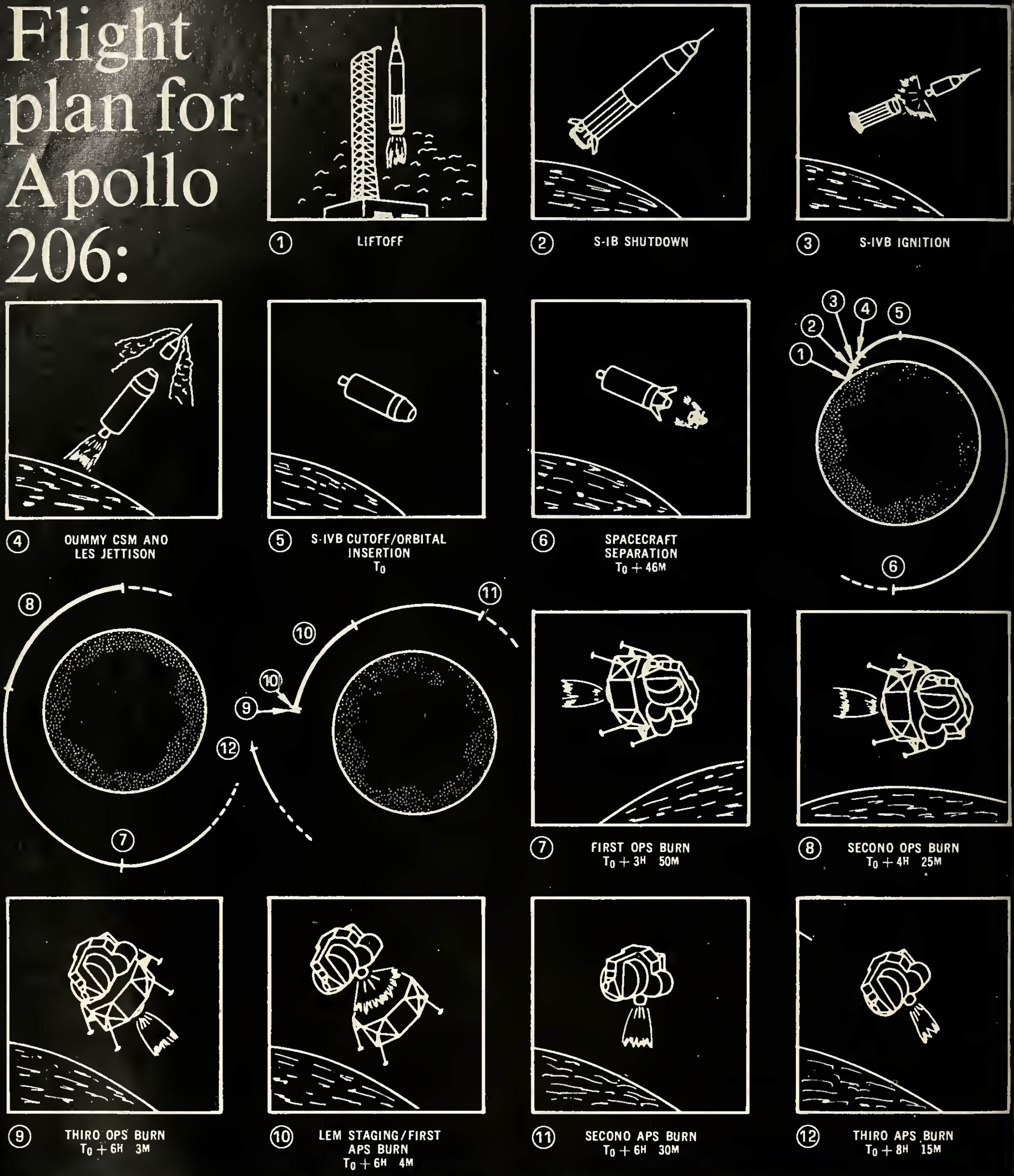
① LIFTOFF
② S-IB SHUTDOWN
③ S-IVB IGNITION
④ DUMMY CSM AND LES JETTISON
⑤ S-IVB CUTOFF/ORBITAL INSERTION T_0
⑥ SPACECRAFT SEPARATION $T_0 + 46^M$
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⑦ FIRST DPS BURN $T_0 + 3^H\ 50^M$
⑧ SECOND DPS BURN $T_0 + 4^H\ 25^M$
⑨ THIRD DPS BURN $T_0 + 6^H\ 3^M$
⑩ LEM STAGING/FIRST APS BURN $T_0 + 6^H\ 4^M$
⑪ SECOND APS BURN $T_0 + 6^H\ 30^M$
⑫ THIRD APS BURN $T_0 + 8^H\ 15^M$

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WASHINGTON

AAP Contractor Announcement Awaited

Selection of the contractors for systems definition of the *Apollo* Applications Program is imminent. NASA officials indicated the announcement could be made late last week or early this week. The Source Evaluation Board was expected to report to Administrator James E. Webb either May 26 or 27. Two or three firms were expected to be selected for the nine-month studies. One of the firms will be named later to develop the spacecraft.

Additional Pioneer Mission Seen

NASA officials are expected to approve a fifth *Pioneer* interplanetary mission. It will make use of a spacecraft originally procured from TRW Systems Group as a spare. The probe will be launched in late 1968, in time to monitor the expected peak of solar activity. The spacecraft will carry the same experiments as the third and fourth in the *Pioneer* series.

Surveyor Landing Sites Spelled Out

Landing site for *Surveyor* launches on May 30-31 and June 1-2 is a 100-kilometer circle centered at 43 degrees 30 minutes west longitude and 30 degrees 30 minutes south latitude. One of the major landmarks in the area is the Crater Flamsteed. The same area is also listed as the ninth *Lunar Orbiter* site. The landing site for launches on June 3-4-5 will also be a 100-kilometer circle listed as the eighth target for *Lunar Orbiter*. It is 37 degrees west longitude and 4 degrees south latitude. It is a flat area with no discernible surface marks.

NASA Picks OGO Hardware for AF Ride

NASA has approved the first major experiment it will fly on an Air Force mission on a space-available basis. The test will utilize the *Orbiting Geophysical Observatory (OGO)* horizon scanner equipment to make measurements. Although the agency has not announced what launch vehicle or Air Force spacecraft will be involved, it is believed to be one in the unmanned series.

Gemini 9 May Force OGO Slippage

Launch of the third *Orbiting Geophysical Observatory (OGO)* is scheduled for May 31. It is expected to be delayed however, until June 4 because if the *Gemini 9* mission is launched, space agency officials say *OGO* cannot be launched until after recovery of the astronauts. Since this will push *OGO* into next weekend, rescheduling for early next week is almost certain.

Soviet Missile Subs Make World Cruise

Underwater cruise of a group of Soviet atomic-powered submarines around the world completed late in March took slightly more than a month and a half and covered 40,000 km. The cruise, under command of Rear Adm. A. I. Sorokin, followed a course around the tip of South America, through the Drake Passage and Antarctica. A Soviet report on the submarines says they "are armed with rockets capable of hitting sea and land targets hundreds and thousands of kilometers away with high accuracy . . . and with torpedoes capable of carrying nuclear warheads."

Pacific Polaris Fleet Growing

Four U.S. *Polaris*-carrying nuclear submarines are now deployed in the Pacific, according to the Navy. Three more are to take up undersea patrols in the Pacific by the time the complete 41-vessel force is operational late next year.

Vietnam Needs Preempt Industry Briefing

Air Force's Electronic Systems Div., Hanscom Field, Mass., has postponed until fall a classified advanced planning briefing it had prepared for industry June 28-30. ESD spokesmen say the meeting was cancelled after a review of activities showed it could be put off "to assure support for urgent requirements in Vietnam."

Navy To Certify Submersibles

Navy spokesmen say they expect policy for the safety certification of undersea research vehicles to be set soon by a Secretary of Navy instruction now being reviewed at high levels. Under the new regulation, the Navy will certify all its own vehicles and any submersibles working under Navy contracts.

INDUSTRY

Boeing Will Build JPL Solar Array

The Boeing Co. has been selected to build a high-power solar array system for the Jet Propulsion Laboratory. The contract is expected to be worth about $5 million over a three-year period. The deployable solar cell panel will be 1,250 ft. long.

NASA Names Data Bank Contractor

The space agency is moving to complete design of a data management system that will be part of the joint NASA/DOD data bank. Peat Marwick Livingston, Inc., has been selected for a six-month, $100,000 study of the NASA facility, which will be located at Langley Research Center. The system, which will be linked with the DOD Documentation Center in Virginia, is expected to be operational in FY '67.

NASA-Comsat Pact Detailed

The three-year contract NASA is negotiating with Communications Satellite Corp. will cost $27,795,000. Adding the costs of contracts with foreign partners, the total price tag will come to $38,964,000. While NASA will use an average of 46% of the total satellite service for the *Apollo-Saturn* program, other users may buy service at a monthly rate under a fixed tariff.

INTERNATIONAL

Russians Seek Satellite-Tracking Help

The Soviet Union is making increasing efforts with Soviet bloc or sympathetic countries to augment its satellite-tracking and telemetry capabilities. Recent moves include a nine-day course at Tashkent in optical tracking techniques for bloc scientists and conclusion of an agreement with the United Arab Republic to provide Helwan Observatory with satellite-tracking equipment.

Oceanography Shift Seen

The anticipated shift in emphasis from pure research work in the oceans to oceanographic projects with useful goals is seen in the Fiscal Year 1967 National Oceanographic Program released by the President.

Although the $83.4-million research portion of the $220-million national program is still the major single expenditure, the combined ocean engineering and instrumentation budget request of $74.3 million runs a close second.

Inclusion of ocean engineering in the program for the first time and greater emphasis on the exploitation potentials of the Continental Shelf indicate that national planners are looking toward payoffs on long-term Federal investment in the oceans. No major new programs will be started in the next fiscal year, but greater potentials for industry loom in this perceptible change of national viewpoint.

Three major advances—In his transmittal letter of May 18, the President singled out three ocean engineering projects as respresenting significent national advances: Sealab II, Project Mohole and the nuclear-powered oceanographic research submarine NR-1, now under construction at General Dynamics' Electric Boat Div.

Mohole, of course, is in jeopardy since the House Appropriations Committee deleted the $19.7 million FY 1967 Administration request for the project (M/R, May 16, p. 8). In terms of budget, Mohole is the second largest effort in the ocean engineering area of the national program.

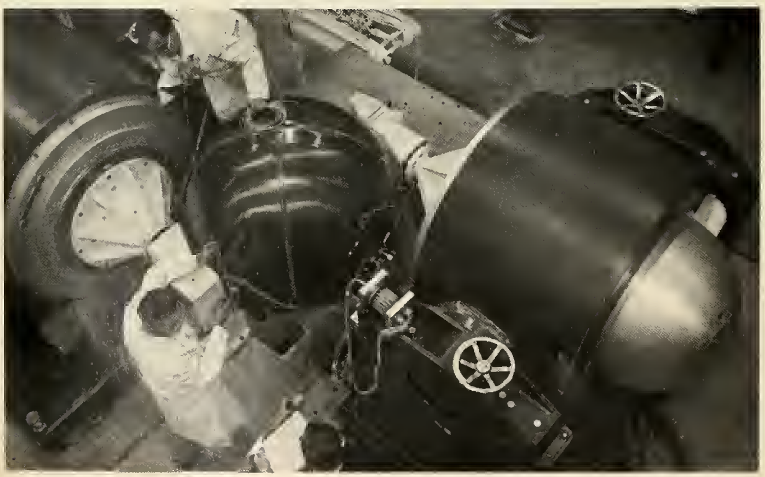
The Navy's Deep Submergence Systems Project (DSSP), with a $32.8-million request, is the major program in ocean engineering. DSSP may have even more funds in FY 1967 since the House Appropriations Committee recommended an additional $8.6 million for this project.

The national program has been prepared annually by the Interagency Committee on Oceanography since 1964. This fiscal year, the planners have provided details on the Continental Shelf work of the nine ICO departments and agencies. They reported that more than 40% of the ICO efforts "contribute to our knowledge of the shelf and its contents." The Federal Government must "assess—now—the scientific requirements and specific opportunities inherent in cxploration" of the Continental Shelf, the group said.

The agreement at the Convention on the Continental Shelf in June, 1964, which granted signatory nations the right to exploit their Continental Shelf to the 200-fathom curve or as far practicable, focused the attention of ICO planners on the shelf and its exploitation potentials. The treaty increased U.S. real estate by 850,000 sq. mi.

Hardware lag—The program planners lamented the continued lag in oceanographic instrumentation development, blaming lack of hard specifications and poor reliability. Still, instrumentation is the only functional area of the program which is down from last fiscal year. The $8.4-million request is about $1 million less than the previous year's.

The program offers encouragement to builders of undersea research vehicles (URV's) since funds have been set aside for a charter "to obtain operating experience and to evaluate their usefulness in oceanographic research." After gaining operating experience in URV's, the Naval Oceanographic Office will develop firm design requirements for two shallow-depth vehicles in FY 1967.



Atlas Failure Cause Cited

The space agency has pinpointed the cause of the *Atlas* booster failure during the aborted *Gemini 9* mission May 17.

A Failure Analysis Board reported that the gimballing of the booster engine which forced the *Atlas-Agena* into a hardover trajectory was caused by a short in the electrical command circuit in the engine pitch servo valve.

Although several other failure modes could have caused a similar occurrence, the agency said, the pinpointed cause was the only one which could have resulted in the exact set of data that was received from the launch vehicle.

The malfunction was called a random failure, but to ensure that it does not happen again, new tests will be made on the *Atlas* and electrical connections in all new boosters will be X-rayed.

LEM Tanks Undergo Tests

Spherical propellant tanks for the Lunar Excursion Module ascent propulsion system are now in qualification testing at Aerojet-General Corp.'s Downey, Calif., plant.

The titanium vessels weigh 75 lbs. and are designed to hold more than a ton of liquid propellant at flight pressures of 100 psi. Two of the 4-ft.-dia. tanks will be mounted in the LEM and face acceleration stress-loading up to 15 g's.

Each tank is fabricated from two hemispheres, joined by vacuum welding, and two mounting cone/pin supports, an access cover, a helium inlet and an anti-vortex baffle.

The hemispheres are welded together at a 45-degree angle from the tank centerline to avoid intersecting the four high stress areas. Production models of the tanks must pass hydrostatic tests at 333 psi, vibration tests (shown at left) at 20 to 2,000 cps along each axis while empty and balance capacity and leak tests.

Qualification models also must pass acceleration and shock tests as well as burst, hydrostatic cycling, loaded vibration, creep and instrumentation tests.

The tanks will then be shipped to Grumman Aircraft Engineering Corp.

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MOL's zero-g liquids need more sophisticated gaging

A routine liquid-gaging system would be about as effective at zero gravity as an old-fashioned dip stick. Developing the right system for the Manned Orbiting Laboratory will require progressive thinking, by a highly specialized company of *demonstrated* competence.

Simmonds designed, developed and produced the highly successful Propellant Utilization system for CENTAUR, and is now producing a series of measurement systems for other space vehicles (APOLLO's Propellant Utilization and Gaging system and LEM's Propellant Level Detector). They add up to state-of-the-art know-how in zero-g gaging, backed by unequaled experience in other space-liquid gaging systems.

These qualifications are complemented by the most advanced scientific and engineering skills in the field, superbly equipped R & D and production facilities, and a history of product reliability. In all, a cross section of Simmonds' unique ability to meet the demands of a zero-g gaging system for MOL.

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collage

A random collection of fact, opinion and miscellany... some of it a blatant attempt to peddle the products and capabilities of Motorola's Military Electronics Division.

HOLY INTERFEROMETERS!
We've been one-upped by the camp followers..

While we're not trying to pass judgment on the American public's taste (or lack thereof), we *are* disturbed by the recent TV popularity of that comic-book character with the dumb-looking mask and cape. The reason is that we suspect *we* were responsible for the Batman revival... and we're not getting any of the credit, blame or money.

About a year ago we ran a tongue-in-cheek advertisement comparing Motorola radar to bat radar. Our point was that while bats have nice little functional echolocation systems, they can hardly compare with Motorola's airborne radar in terms of range, reliability, maintainability and versatility.

Not everyone liked our irreverent approach, and word must have gotten around in show biz circles that there was a lot of sympathy going for bat-type creatures. The rest is history. We're not sure if we have grounds for a suit, but the legal department is checking.

Anyway, if you make it to the AFCEA Exhibit this June, stop by our booth for your very own Motorola BATKIT. Or write to either of our Centers and we'll send you one, along with some other data on highly sophisticated (if not high camp) radar systems.

Continued on page 54

Martin Sprint Pact Grows

Martin Co. has been awarded a $30 million contract from Bell Telephone Laboratories for continued development of the *Sprint* anti-ballistic missile.

The money is another funding increment for the third year of the *Sprint* development program. Total funding to Martin since the inception of the program is $223 million. *Sprint* is part of the *Nike-X* missile defense system.

Shots of the Week

Explorer 23 was launched May 25 from Cape Kennedy aboard a *Delta* rocket. A "hot burn" in the booster's second stage placed the satellite into an orbit some 200 mi. higher than the 750 by 170-statute-mi. orbit originally planned. NASA spokesmen said the higher orbit would probably be "just as useful."

- Britain's *Blue Streak* rocket, first stage for the European Launcher Development Agency's *Europa 1* booster, was fired May 24 from Woomera, Australia. The test was described as "partially successful." The rocket crashed 270 mi. downrange, 190 mi. short of the planned target, after technicians shut off two engines when the rocket appeared to be veering off course.
- The Soviet Union successfully orbited the *Cosmos 119* scientific satellite May 24.

NASA Bill in Conference

House-Senate conferees meeting on the NASA FY 1967 authorization bill have been urged to adopt the House version of a portion of the bill which would give NASA an additional $7.5 million above its original request for the 260-in. solid rocket motor program.

In a speech on the Senate floor during passage of the bill, Sen. Spessard L. Holland (D-Fla.) said that if the U.S. failed to continue development of solid propellants, it would fail in the one thing it "should be doing to catch up with the Soviet Union in the field of space effort."

The Senate bill, which was passed by voice vote May 24, includes only the $3.5 million requested by the Administration for an additional half-length firing. The added House funds would bring this to $11 million and cover a full-length firing of the solid motor.

In other debate over the $5.008-billion measure, Sen. Joseph Clark (D-Pa.), said he felt that national priorities "are substantially out of order when the Senate, in the course of 5 or 10 minutes, passes a $5-billion authorization bill to send a man to the Moon."

Clark was joined in his remarks against the bill by Sen. J. William Fulbright (D-Ark.), who said such action was "typical, today, of any bill relating either to outer space or the military . . . in my view, it is an outrageous distortion of priorities."

Senate Space Committee Chairman Clinton P. Anderson (D-N.M.) made it clear in his opening speech on the bill that the Senate conferees would stick by certain aspects of the Senate bill which differ with the House version. Notably, these are the House Space Committee's inclusion of funds for a landing probe on the 1969 Mars *Mariner* and cancellation of the 1967 Venus *Mariner*.

Anderson said that the committee had examined NASA's planetary proposals very carefully and is convinced that the Venus undertaking is most basic to developing the nation's long-range space program. The flight is necessary to determine whether further consideration of Venus should be given, he indicated.

Ocean Legislation Advances

Hopes for passage of oceanographic legislation this session brightened as conferees on the Marine Resources and Engineering Act of 1966 reconciled differences and reported out.

House conferees acquiesced to the "blue-ribbon" council in the Senate version of the bill, and Senate representatives agreed to a House provision that a study commission would be mandatory and not left to Presidential discretion.

The commission will consist of 15 representatives chosen by the President from Federal and state governments, industry, universities, laboratories and other private oceanographic institutions. It will review "existing and planned marine science activities of the U.S." and submit findings and recommendations to the President, via the council, 18 months after formation. The commission is to be dissolved 30 days after submission of the report.

The council is to be headed by the Vice President. Members will be Secretary of State, Secretary of Navy, Secretary of Interior, Secretary of Commerce, chairman of the Atomic Energy Commission, director of National Science Foundation, Secretary of Health, Education & Welfare and Secretary of Treasury. Dissolvement of the council will occur 120 days after the final report is submitted.

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STRESS

Naturally, it took ingenuity on the part of our engineers to take the stress and strain out of pulsed motors which could be used for such air-launched tactical missiles as SRAM. They devised ingenious ways of case bonding the grain to overcome thermal stress and vibration in static firings. ☐ But it took more than ingenuity to solve the problem prior to simulated flight missions involving vibration and temperature extremes. *Experience* in designing and building solid rocket pulsed motors was important. Lockheed Propulsion Company has the experience; more of it than anyone else. 162 firings to date in Air Force, Navy and company programs. LPC was first to combine the simplicity of a solid motor with the ability to stop and start the motor repeatedly on command. ☐ LPC was also first to build and test a flight prototype 156-inch-diameter solid propellant rocket motor, fired with three million pounds thrust. LPC has fired more 156-inch motors than all the rest of the industry combined. ☐ Ingenuity plus experience adds up to innovation at LPC. And you can become an important part of this "breakthrough" program. Excellent, long-term career opportunities are available to propulsion engineers and scientists in the fields of research, engineering and manufacturing. If you have experience in these areas, write now to: Professional Employment Manager, Department 59, Box 111, Redlands, California. Lockheed is an equal opportunity employer.

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Bids Due Soon on New Nike-X Radar

By Ron Barnhart

New York—Industry bids are expected to be received by the Army within the next 5-6 weeks for a new electronically-scanned phased-array radar for the *Nike-X* anti-ballistic missile system.

The new unit will be designed to greatly increase the acquisition range of the *Nike-X* system against small targets of low observability, Army spokesmen told Missiles and Rockets.

It will, in effect, allow detection of much smaller objects than can now be detected out to the current maximum range of *Nike-Zeus* (believed to be about 400 n. mi.), and will also allow for further growth in the weapon system should an even longer-range *Zeus* emerge in the future.

Requests for industry proposals on the radar went out several months ago. Though it has been tagged a VHF system, Army spokesmen point out that the exact operating regime is not yet determined. It is expected, however, that the radar will operate at longer wavelengths than the current *Nike-X* UHF radars.

The radar mix—The new radar will go into full development shortly, adding a third to the two basic *Nike-X* radars—the Multi-function Array Radar (MAR) and the Missile Site Radar (MSR). There are several configurations of the basic MAR, but Army spokesmen stress that the new radar is a distinct new system.

It is expected to play a key role in any *Nike-X* deployment scheme heavily weighted to area defense against a ballistic missile threat posed by the Chinese Communists or other small nuclear powers. It is upon this threat that most DOD *Nike-X* thinking is now centered (M/R, April 11, p. 12; May 9, p. 12).

Exactly how the radar would be deployed in relation to the other radar components of *Nike-X* depends on the level of defense chosen. The new radar could possibly be deployed without the MAR, the Army reports, thought it would always be linked with MSR.

Army spokesmen also say it has not yet been decided where the first operating model of the radar will be built.

Nike-X MAR and MSR radars are now being installed at the Kwajalein Atoll test complex in the Pacific. A MAR site is to be located on the western tip of Kwajalein. The MSR complex, together with new launch silos for *Sprint* missiles, will be located on Meck Island, 15 mi. north of Kwajalein. First drawings of the MAR and MSR complexes and proposed operational configurations were released by the Army here last week at the annual Aviation/Space Writers Assn. meeting (see accompanying photos).

Confidence voiced—Speaking at the AWA meeting, Dr. Oswald H. Lange, chief scientist in the Army's *Nike-X* project office at Redstone Arsenal, expressed "high confidence" that the *Nike-X*, if properly deployed, can perform its intended ABM role.

Lange said that the recent work on *Nike-Zeus* has resulted in not only extended range, but also a more maneuverable missile with a greater kill-area capability. "The longer-range version of *Zeus* would destroy or damage nearly everything in a cloud of decoys and warheads," Lange said.

He also said that "giant strides" have already been made in the *Nike-X* data processing subsystems. He looks for steady, but less spectacular, improvements in both the *Zeus* and *Sprint* propulsion and kill-mechanism systems.

Lange told M/R that "political considerations aside," he believed "*Nike-X* should be deployed. However," he added, "the extent of the deployment is a moot point. Personally, I think the original deployment could well be moderate because the system is so flexible that extensions to it or improvements in it can be rapidly incorporated as they become available." ■

Schriever Urges Scramjet Progress

Air Force Systems Command chief Gen. Bernard A. Schriever once again has urged a large-scale investment in the Scramjet supersonic-combustion technology for future hypersonic vehicles (see p. 72).

Speaking at the annual Aviation/Space Writers Assn. meeting in New York May 24, Schriever said that if the U.S. is to have the option of building vehicles in the early 1970's capable of flight in the atmosphere at speeds between Mach 4 and Mach 20, the investment must be made today.

Schriever, rapping the theory put forward by some scientists that U.S. military technology has reached a plateau, said the spectacular advances of the past decade have opened up even greater prospects.

For example, he said that progress on composite materials made of boron and other fibers has gone even faster than predicted. "Production costs have been drastically reduced, and a further reduction will take place this year. Predicted strength figures for boron have been surpassed, and carbon filaments promise even greater strength-to-weight ratios.

"In addition," Schriever said, "a new plastic binder with increased temperature resistance has been produced in the laboratory."

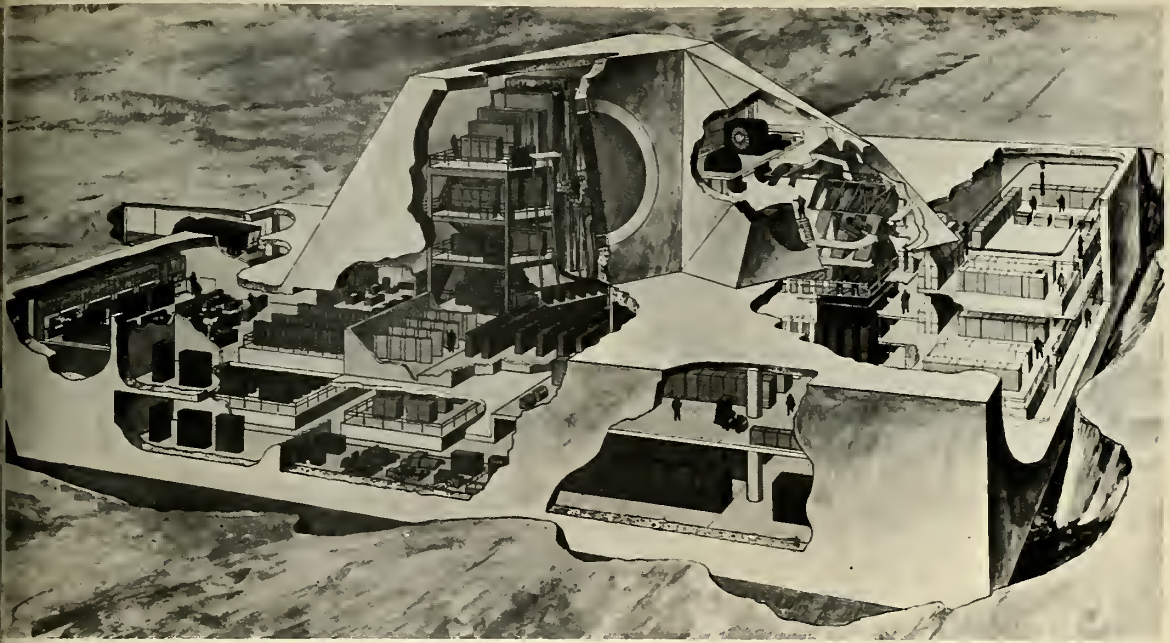
Use of boron composites in the F-111 aircraft could save 350 lbs. in the tail section, he said. Schriever also said that through use of new composite materials, new oxide-dispersed metals for engine strength at high temperatures, and new aerodynamic concepts such as laminar flow control, a 10,000-mi.-range aircraft could be made out of one that now would have a 3,000-mi. range.

Schriever said there are at least three factors that could restrain the full advancement of technology in this country.

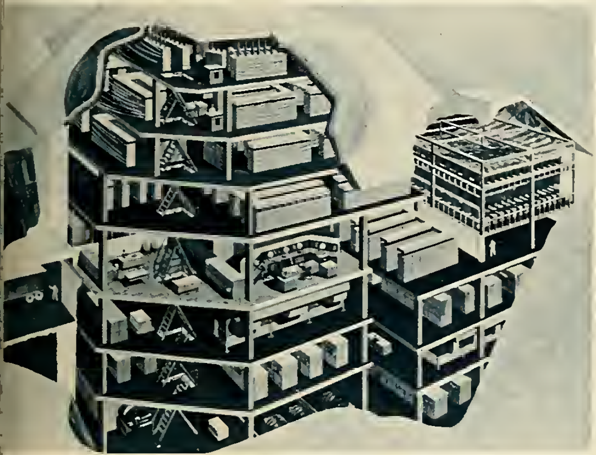
One is the relative silence of U.S. opponents. He said that in many instances, Soviet basic research is reported in scientific journals and then disappears from view until "we rub our eyes at the appearance of an anti-missile missile or space weapons system and ask, now where did that come from?"

The second constraint he sees is the argument that U.S. military R&D could be "provocative" to opponents. "This argument overlooks the fact that our very existence as a free society is provocative to our opponents because it contradicts their theory of history."

The third constraint is the immediate need for funds for Vietnam. The general warned against neglecting the long-range challenge to our national security even with a war going on.

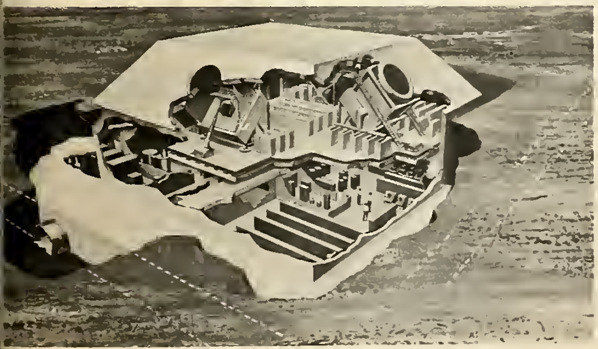


Newly released drawing shows Nike-X MAR radar that is being installed on Kwajalein. It is similar to that proposed for an operational tactical MAR, with changes for systems test.



Cutaway of presently envisioned tactical MAR as it would look operationally. Large central dome houses receiver apparatus and smaller domes house transmitters. Combination of one receiver face and one transmitter face would give a single-quadrant scan.

Sprint missile, left, and Nike-Zeus are shown side by side for size comparison, mounted on truck.



Cutaway of the MSR in a tactical configuration. The radar will be installed on Meck Island, 15 miles north of Kwajalein.

Surveyor test vehicle is shown during the successful test of its retro-propulsion system at Holloman AFB, N.M., May 20. The spacecraft was slowed to a speed of 3½ mph before free-falling the last two feet. The flight started with a balloon drop at 950 ft.

Surveyor, Gemini Poised for Launch

by Hal Taylor

WASHINGTON—The space agency this week will attempt a space tripleheader with the planned launches of the first U.S. lunar soft-landing *Surveyor* spacecraft and the *Gemini 9* spacecraft and its Alternate Target Docking Adapter (ATDA) vehicle.

Scheduled to blast off the pad from Cape Kennedy first will be the 2,100-lb. *Surveyor* on May 30. The launch window opens at 9:38 a.m. EST and closes at 10:28 a.m.

Launch of the ATDA target vehicle as part of the *Gemini 9* mission is slated for May 31 at 10:00 a.m. EST. The two-man *Gemini 9* spacecraft with Command Pilot Thomas Stafford and Pilot Eugene Cernan will follow 99 minutes later at 11:39 a.m. EST. They will attempt to rendezvous with the ATDA as they reach the third apogee of the orbital flight.

Alternate launch schedule—Space agency officials in the Offices of Manned Space Flight and Space Sciences and Applications have already reached an agreement covering contingency planning if the *Surveyor* launch is delayed.

If the slip lasts one or two days, the *Gemini* flight will be delayed until one day after the *Surveyor* liftoff. If the slip is three or four days, however, *Gemini* program officials will have the option—and probably will use it—of launching their two vehicles first.

One other constraint may also affect the launch. If *Gemini* goes first, the *Surveyor* will not be able to be launched during the extravehicular activity (EVA) portion of the flight because manned spaceflight officials want all ground tracking facilities to support the astronauts. EVA is currently scheduled early in the second day of flight.

Surveyor—The first U.S. unmanned lunar soft-landing mission is expected to last 61 to 65 hrs. While the Soviet Union has already beaten this country to that space objective with the successful touchdown of *Luna 9* on the Moon Feb. 3, *Surveyor*, if successful, could top the Soviet feat in certain areas. In addition to photographing a different area of the lunar surface, the U.S. payload on the Moon will weigh some 620 lbs., compared to the 200-lb. Russian vehicle. It will also be able to use its television camera to photograph the spacecraft foot pads indicating how deep they have sunk into the surface.

Surveyor will be launched by an *Atlas/Centaur*, which will be making its first operational flight. The launch window begins May 30 and stretches into June 5. Prime days for a launch during the period are May 30 to June 2. June 3 and 4 are considered poor because of some Earth shadow constraints and the June 5 launch opportunity is a brief one. If the spacecraft is not launched during that period, the next launch window opens June 28.

The *Surveyor* flight will be a direct-ascent mission with only one burn of the *Centaur* engines. The *Atlas* booster engine will cut off after 142 secs. of flight with sustainer engine cutoff at 240 secs. Ignition of the *Centaur* will occur at about 251 secs. into the flight with a planned burn of 434 secs.

The spacecraft will be aimed at the west end of the planned project *Apollo* lunar landing area. If a mid-course guidance correction is required, it will be made 16 to 20 hrs. after launch.

The terminal sequence of the flight begins about 1,000 mi. above the surface when small gas jets will be used to slow its descent. At an altitude of 25,000 ft., the main retro-propulsion system, weighing some 1,377 lbs., is ejected and the vernier retro-system takes over. Speed at this time should be about 240 mph.

The vernier engines will slow the spacecraft to a speed of 5 mph some 14 ft. above the surface. At that time, the spacecraft will free-fall the remainder of the distance to the surface.

Gemini 9—The *Gemini 9* mission will be an almost complete replay of the flight which was scrubbed on May 17 when the *Atlas* booster engine swiveled erratically and drove the *Agena* target vehicle into the ocean. In addition to the substitution of the ATDA, a rendezvous attempt simulating that required during the lunar landing mission will be changed slightly.

The flight plan, however, still calls for rendezvous during the third revolution, two re-rendezvous attempts, three dockings and the 2-hr., 25-min. space walk by Cernan.

Dropped from the flight schedule is the plan to re-ignite the target vehicle while docked to the *Agena*. This cannot be done because the ATDA has no propulsion system.

The ATDA will not be stabilized during the extravehicular operation. Its attitude control system will be shut down to ensure that the hot firing does not damage Cernan's spacesuit. ■

LEM Rendezvous Decision Expected

by Jinx Mercer

HOUSTON—A decision is expected in the near future on a multimillion-dollar contract covering hardware for the *Apollo* spacecraft's Lunar Excursion Module (LEM) rendezvous system.

The selection will be made from two competing systems—the rendezvous radar/transponder system developed by Radio Corp. of America and the LEM optical rendezvous system developed by Hughes Aircraft Co.

The parallel development effort alone cost close to $100 million. Hardware will cost many additional millions.

Dr. George E. Mueller, Associate NASA Administrator for Manned Spaceflight was briefed on the merits of the two systems at a meeting of top manned spaceflight officials at Cape Kennedy last week. It is believed the selection of either RCA or Hughes to build the follow-on system will be made in the next two weeks. One note of uncertainty affecting the timing of the announcement is whether there will be sufficient disagreement between officials at NASA Headquarters and Manned Spacecraft Center so that Administrator James E. Webb will have to make the final decision.

Management vs. astronauts—It is believed that Dr. Mueller and Dr. Joseph Shea, director of *Apollo* spacecraft development at MSC, both favor the optical system, primarily because it would result in a great saving in total spacecraft weight.

The astronaut office at MSC and most of the astronauts favor the radar system because they are accustomed to operating a radar system in the *Gemini* program.

One other factor that could affect the final decision is that there is some doubt among NASA officials that the optical system—which entered development after the radar system—will be ready in time for inclusion in the *Apollo* program.

Background—Rendezvous in lunar orbit, as originally conceived, depended upon a radar-guided trajectory computed aboard the LEM during ascent from signals returned by a transponder aboard the Command and Service Module mother ship.

Responsibility for the development of the LEM rendezvous radar/transponder system was given to RCA's Aerospace Systems Div. Grumman Aircraft Engineering Corp., prime contractor to NASA for LEM, awarded the $23.5-million subcontract in 1963.

As the LEM developed, however, it exceeded the design (fully fueled) weight of "under 32,000 lbs." Mission planners were advised that an alternate rendezvous system, built around an automatic tracking system, would be less complicated, more reliable and 65 lbs. lighter. The weight factor alone would allow weight-conscious program officials to trim 440 lbs. from the spacecraft "stack," and thousands of pounds from the overall vehicle.

To evaluate the merits of each system and study the tradeoffs in size, weight, power drain, simplicity and operation, NASA approved parallel development. Total development costs, including testing and acceptance of the hardware, would amount to less than $100 million for both systems.

AC Electronics Div. of General Motors Corp., prime contractor to NASA for the *Apollo* guidance and navigation system, selected Hughes Aircraft Co. in mid-1965 to develop the LEM optical rendezvous system.

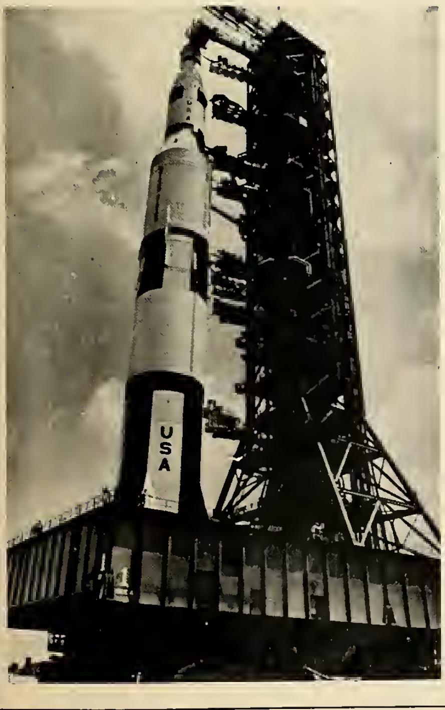
Optics—The optical tracker consists of a gimballing telescope that can automatically track in two operational modes and one "emergency backup" mode. Before LEM liftoff, the tracker would be used to align the vehicle's platform using appropriate stars. After liftoff, the tracker would be switched to a beacon tracking mode to seek out and lock onto the high-intensity, flashing beacon of the Command and Service Modules orbiting 80 n. mi. above the lunar surface.

Data being fed into the computer would consist of angle and azimuth as a function of time. The computer, in turn, would display direction and thrust information to place the LEM on a rendezvous path with the mother ship.

In emergency mode, or beacon failure, the tracker would be capable of tracking the Command and Service Modules during periods in which they are illuminated by the Sun.

Radar—The RCA-developed rendezvous radar/transponder system is a phase-modulated continuous-wave radar operating in the X-band and has a 400-n.-mi. range. The radar is designed to provide range, range rate, azimuth and elevation information to the LEM computer, which displays direction and thrust information to the pilots.

The RR/T system, proponents say, will display range and range rate information even if the onboard computer fails. This same information with the optical system has to be processed by computer. The radar can also serve as a backup to the LEM landing radar during lunar descent, MSC engineers point out, tracking a lunar-based transponder delivered by a *Surveyor*. ■



Saturn V System Tested

The Saturn / Apollo 500F facilities model rolled out of the Vehicle Assembly Building at Cape Kennedy for the first time May 25 in the first full-scale test of the Saturn V, the Apollo spacecraft, the launch umbilical tower and crawler in combination. Manual leveling of the crawler had to be used as the mammoth combination moved toward the launch pad 3½ mi. away at less than one mile per hour. The autopilot, which automatically levels the trouble-plagued crawler, was not functioning.

NASA Procurement Drops in FY '66

WASHINGTON, D.C.—Space agency procurement in the first half of Fiscal Year 1966 was down 5% to $2.779 billion, compared to $2.927 billion in the same period for FY '65.

About 83% ($2.309 billion) was placed directly with business firms, $76 billion below the level in the first half of FY '65.

Two per cent ($44.2 million) was placed with educational institutions, nine per cent ($249.5 million) with other Government agencies, and $14.3 million with non-profit institutions.

The one contractor whose share of total NASA procurement increased over the same period of the previous fiscal year was Jet Propulsion Laboratory (JPL). Its share rose from $128.8 million to $145.3 million.

In addition, the space agency said that 90% of the contracts placed with other Government agencies and 77% of the awards to JPL resulted in contracts with industry.

North American Aviation, Inc., once again led in the amount of contracts awarded industrial firms. The company received $731,220,000, 31.67% of the total awards to business. NASA's top 50 contractors for the period are listed on the right.

The semi-annual procurement report released last week also revealed the continuing sharp upsurge in the agency's use of incentive-type contracts. During the six-month period, NASA awarded 41 new incentive contracts and converted two cost-plus-fixed-fee contracts to incentive awards. Target value of all incentive contracts as of Dec. 31, 1965, totaled $2.184 billion, more than three times the total at the end of the first half of Fiscal 1965.

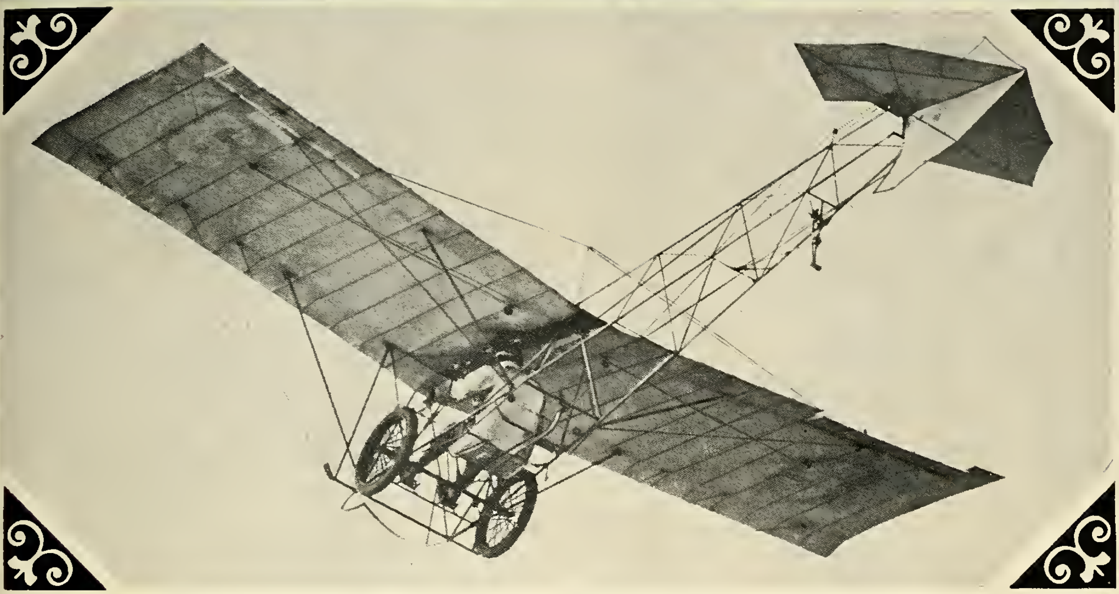
Small business firms received $115 million (5%) of the total awards to business. Small firms also received substantial subcontract awards from NASA prime contractors. Aggregate total of direct awards and subcontracts going to small business was $335 million, 15% of the agency's total business with industrial firms in the period.

The state of California continued to receive the largest amount of NASA awards with $1.1 billion, 49% of the total. The remainder of the top 10 states included New York, $234 million (10%); Louisiana, $218 million (10%); Wisconsin, $75 million (3%); Florida, $72 million (3%); Missouri, $45 million (2%); Maryland, $39 million (2%); and Washington, $36 million (2%). The other 40 states and the District of Columbia together received only 8% or $199 million.

As expected, the two NASA centers distributing the largest share of direct awards were Marshall Space Flight Center with $993.2 million (35% of the total) and Manned Spacecraft Center with $877.6 million or 31.6%. ■

CONTRACTOR	RANK JULY-DEC. 1964	NET VALUE OF AWARDS	
		THOUSANDS OF DOLLARS	PERCENT OF TOTAL AWARDS TO BUSINESS
TOTAL AWARDS TO BUSINESS		$2,309,251	100.00
1 North American Aviation, Inc.	1	731,220	31.67
2 Boeing Co.	2	208,512	9.03
3 Grumman Aircraft Engineering Corp.	3	187,698	8.13
4 Douglas Aircraft Co., Inc.	4	142,337	6.16
5 General Electric Co.	6	141,268	6.12
6 Aerojet-General Corp.	5	83,223	3.60
7 General Motors Corp.	18	74,652	3.23
8 International Business Machines Corp.	8	57,348	2.48
9 Chrysler Corp.	10	46,282	2.00
10 McDonnell Aircraft Corp.	7	44,682	1.93
11 General Dynamics Corp.	9	37,053	1.60
12 Bendix Corp.	12	32,477	1.41
13 TRW Inc.	13	24,683	1.07
14 Radio Corp. of America	11	20,269	.88
15 Lockheed Aircraft Corp.	21	20,029	.87
16 United Aircraft Corp.	14	17,038	.74
17 Fairchild Hiller Corp.	22	16,431	.71
18 Hughes Aircraft Co.	17	16,216	.70
19 LTV Aerospace Corp.	30	16,193	.70
20 Brown Engineering Co.	19	13,902	.60
21 Sperry Rand Corp.	24	11,790	.51
22 Union Carbide Corp.	33	11,773	.51
23 Philco Corp.	20	11,332	.49
24 Hayes International Corp.	16	10,560	.46
25 Bellcomm, Inc.	23	10,087	.44
26 Thiokol Chemical Corp.	—	9,573	.41
27 Collins Radio Co.	15	8,194	.35
28 Mason-Rust	26	6,848	.30
29 Northrop Corp.	46	5,570	.24
30 Honeywell, Inc.	29	5,569	.24
31 Air Products & Chemicals, Inc.	54	5,356	.23
32 Graham Engineering Co.	36	4,582	.20
33 Vitro Corp. of America	72	4,499	.19
34 Westinghouse Electric Corp.	31	4,346	.19
35 Space, Inc.	42	4,281	.19
36 Zia Co.	35	4,168	.18
37 Control Data Corp.	32	3,258	.14
38 Federal Electric Corp.	—	3,213	.14
39 Management Services, Inc.	—	3,173	.14
40 Bechtel Corp.	—	3,049	.13
41 Sanders Associates, Inc.	—	3,000	.13
42 Pacific Crane & Rigging Co.	—	2,955	.13
43 American Science & Engineering, Inc.	—	2,823	.12
44 Documentation, Inc.	53	2,776	.12
45 Avco Corp.	44	2,472	.11
46 Norair Engineering Corp.	—	2,468	.11
47 Space-General Corp.	—	2,367	.10
48 Telecomputing Services, Inc.	100	2,265	.10
49 Martin Marietta Corp.	50	2,212	.10
50 Aero Spacelines, Inc.	63	2,168	.09

THOSE MAGNIFICENT MEN IN THEIR FLYING MACHINES



"Dumont Demoiselle" From the 20th Century-Fox motion picture "Those Magnificent Men in their Flying Machines".

... Hedge Hopper

The Demoiselle, the smallest flying machine in the world, was built in 1909 by Albert Santos Dumont, who weighed only 110 pounds. The plane looked and hopped over hedges like a May bug. It is a sad fact that when other, heavier flyers flew it, the plane refused to rise more than a few feet off the ground. It was, nonetheless, an ingenious aircraft for its time.

A hedge hopper of sturdier characteristics is the A-6A Intruder now being produced by Grumman for the U. S. Navy. A unique system of airborne electronics, radar, computers, cockpit displays and digital navigational systems, the Intruder is a low-level, terrain-following aircraft that can, with a wide variety of means, detect and destroy targets completely obscured by weather or darkness. The Intruder, carrying a useful load greater than its empty weight (approximately 26,000 lb. aircraft with a 54,000 lb. maximum catapult gross weight), is now performing yeoman service in Vietnam.

Where are the bold spirits who will design the aircraft of the future? Many are at Grumman now. Others will come at the "right time and clime." At Grumman, the time is now . . . the clime is kind. Engineers and scientists are invited to act now on the following immediate positions:

◆

Attack and Reconnaissance Systems Engineers—BS or advanced degree with a minimum of 3 years experience in overall development of airborne attack and reconnaissance systems. Knowledge of components which comprise these systems such as analog and digital special purpose computers, displays, sensors including radar, inertial platforms, IR and visual or photographic inputs, guidance and control, and autopilots is essential. Duties include: definition of the requirements for the systems, analysis and synthesis of the systems, simulation, and flight development for final verification.

Systems Engineers—Facility and Services—BS or advanced degree with a minimum of 2 years experience in establishing the requirements for facilities and the criteria for the evaluation of existing facilities. Applicants will be required to survey tests and operational sites both ashore and afloat to verify weapon system compatibility with existing facilities and support equipment. Ability to recommend and/or originate solutions to preclude potential interface difficulties is necessary. Recent military experience and/or good working knowledge of military organization desirable.

Interface Control Engineers—to coordinate development of technical interface areas with other contractors in a major spacecraft development program through a formal interface control program. Applicants must have sufficient background to negotiate the interfaces, effectively coordinate the detailed work on both sides in consideration of system requirements, and obtain detailed agreement from the participants. Tasks include participation in formal coordination meetings, review of all technical interface information with design specialists, maintenance of interface program status records, etc. Applicants should possess a BS degree in ME, EE or physics, and a minimum of 3 years of experience in interface control work.

Additional opportunities on following page

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(Continued from previous page)

Systems Integration Engineers—To integrate major Aerospace systems in a manner which assures achievement of system requirements & operational goals. Systems involved include flight vehicles, ground support equipment & checkout & test facilities covering all program phases from conception to final use. Applicants should possess a willingness to cover many technical areas & the ability to effectively communicate with all types of Aerospace specialists. B.S. in Engineering or Physics is required & systems integration experience preferred.

Human Factors Engineers—MA or PHD in Experimental Psychology with at least 2 years Human Factors experience. BS in Engineering with appropriate experience will be considered. Positions are available in Aircraft Systems Analysis, Display & Control Design, Cockpit Layout, Design for Maintainability, Training Requirements, Training Devices and Experimental Studies.

Carrier Suitability System Engineers—BS or advanced degree with minimum of 1 year experience in establishing operational compatibility of a given weapon system with ship facilities and ship installations. Operational experience is highly desirable. Will establish high density and/or mixed compliment aircraft spotting characteristics, investigate aircraft and ordnance handling, and verify the compatibility of related support equipment and facilities with the aircraft carriers concerned and/or other operational sites and vehicles.

Missiles Systems Engineers—BS or advanced degree with a minimum of 3 years experience in analyzing, integrating, interfacing and developing air launched missile systems. Must be familiar with homing and guidance concepts, control mechanization, kill mechanisms, analytical tools for determining effectiveness, radar techniques, and aircraft interface requirements. Positions encompass interpreting aircraft requirements, evaluating effectiveness, determining interface compatability, and planning and interpreting flight evaluation.

Environmental Control Test Engineers—Must be experienced in writing test plans & reports & conducting development tests on aircraft, air-conditioning, de-icing, rain removal systems &/or space vehicle life support systems. Familiarity with instrumentation requirements & lab equipment essential.

Propulsion Test Engineers—BSME with 1 to 3 years experience in jet or rocket engine testing. Must have ability to write test plans and generate test procedures information.

Fluid Power Design Engineers—B.S. in ME or AE with a sound background in the design, development & installation of fluid power components & systems in military aircraft. Must be thoroughly familiar with all controlling military design requirements & specs.

Seats & Survival Equipment Engineers—B.S. in M.E. with experience in the analysis, design & selection of components which deal with the escape system, safety & comfort of the occupants.

Alighting Gear Design Engineers—BS in ME, CE or AE with minimum of 5 years experience in mechanical systems design & familiar with aircraft design practices. Background should cover some of the following areas: Mechanical linkages & their motion analysis; structural design of mechanical components; determination of power requirements & selection of power supplies; shock attenuation devices; wheels, brakes, anti-skid, & steering devices; & interpretation of military specifications. Duties: Assist in the formation of aircraft alighting gear system concept & in the detail design of the over-all system & its components.

Explosives Engineers—B.S. in Chemistry or B.S. in Chemical Engineering with 5 years experience in design, development & testing of explosives as applied to initators, detonators, fusing, primers, high explosives, delay & pyrotechnic trains. Responsibilities include component specifications, procurement & monitoring subcontractor efforts. Applications are for manned space vehicles.

Aero Configuration, Drag & Performance Aerodynamicists—BS or MS with a minimum of 3 years experience in any of the above categories. Experience in drag & performance prediction should be applicable to conventional or V/STOL aircraft. Will determine & optimize vehicle aerodynamic configuration & determine vehicle aerodynamic characteristics.

Propulsion Technology Engineers—B.S. or M.S. & a minimum of 3 years experience in one or more of the following areas: Fluid Dynamics of air-breathing or rocket propulsion systems; air induction systems & internal aero-dynamics; exhaust systems, nozzles, combustion & propellant analysis; advanced propulsion devices. Analytical &/or experimental background is helpful at both Jr. & Sr. levels.

Air-Breathing Propulsion Engineers—B.S. or M.S. with 3 or more years applicable experience in aircraft or aircraft engines. Knowledge of compressible fluid flow, engine cycle analysis, ejector design, or induction system optimization is required. Experience with trade-of studies including cost, risk, schedule as well as weight, mission, fuel, volume & complexity is desirable. Opportunity available for growth into position of propulsion project leader on aircraft projects & advanced development programs.

NOTE: Positions also available in the above areas to Recent Engineering Graduates

Use the attached inquiry form to arrange a mutually convenient interview.

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Degree	Subject	Year

Major Specialty__________Yrs._____Other Specialty__________Yrs._____

Applying for position(in)(of)__________

Background and experience (Brief resume of experience, recent history of employment. If available, attach prepared resume.)

Technical Countdown

MATERIALS

Closed Tubular Extendable Boom Built . . .

A new type of collapsible tubular boom for space application as an antenna or deployment device has been developed by Boeing's Space Div., Seattle. Spokesmen say the concept is a departure from the DeHavilland storable tubular extendable member (STEM) currently in use in U.S. space R&D, since it is a closed tube that flattens out and rolls up on reel as a double sheet, while STEM is a single-sheet, open tube. Boeing has constructed an 8½-ft.-long tube of 0.005-gauge PH15-7MO stainless steel for demonstration purposes, claiming inherent advantages over the STEM tube: greater torsional strength, flanges by which a flexible array can be attached between two booms, and the ability to transfer fluids.

. . . and Westinghouse Develops Another

Compact spools of flat 2-in.-wide beryllium-copper that can be deployed in space as long slender tubes to function as stabilizers or antennas are being developed by Westinghouse Electric for NASA. The firm's aerospace division is now in the advanced stage of developing a configuration capable of withstanding the temperature variations of space without distortion. The Goddard Space Flight Center contract calls for 150-ft. booms but Westinghouse research indicates its approach would permit tubes as long as 10,000 ft.

. . . but Fairchild's Longest Will Fly First

Under contract to NASA for nearly a year, Fairchild Hiller Corp.'s four 750-ft. and two 400-ft.-long beryllium-copper tubular extendable elements will be employed for antennas and stabilization on the *Radio Astronomy Experiment* satellite.

Glass-Wound Casings Get Nuclear Test

United Technology Center will design and fabricate 30 sections of 10-in.-dia., 20-ft.-long glass-fiber-reinforced plastic casings to house instruments for underground nuclear tests. The glass-wound casings are being considered as a replacement for steel piping now used because the reinforced plastic is not an electrical conductor. The sections will be connected by a UTC-designed threaded joint. Glass casings of the same diameter and strength as steel are believed to be able to sustain the tensile loads and external pressures well below 5,000 ft. The AEC will evaluate the material in this initial 500-ft. length.

ELECTRONICS

Acoustical Astronaut Perfected

Personal communications systems will be evaluated and tested on an electrical acoustical-testing dummy designed and built by CBS Laboratories to represent every contour of the average astronaut's upper torso and head to within 0.10 in. Since these contours—the texture of the skin and clothing, and the size of the astronaut—all have a bearing on sound quality, the dummy will permit calibration of communications equipment to a fine degree. CBS experts have provided the dummy with a "sense of hearing" and have simulated the changing frequency response of the human ear at various loudness levels over a 100-db range. Additional electronics gives the dummy a voice greater than the 100-db pressure level. The device will be used by NASA's Manned Spacecraft Center.

Missile Splashdown Detector Delivered

A radar system designed to detect the water impact point of experimental missiles has been delivered to the Army Missile Command, Redstone Arsenal, by Westinghouse Electric's Surface Div. The feasibility model, built for the *Nike-X* project office under a $400,000 contract, will be installed at Kwajalein. The purpose of the system, says James E. Beggs of Westinghouse, is to locate incoming warheads for positive scoring and rapid recovery. Mounted on a 100-ft. tower, the system has two back-to-back, dish-type antennas and a recording unit that picks up splashdown data.

PROPULSION

Phoebus Nozzles Forged

Nozzle components for the Phoebus rocket reactor have been forged from Hastelloy X and Type 347 stainless steel by Wyman-Gordon Co. One of the Hastelloy X components represents the largest closed-die forging ever made with this material. Type 347 ingots weighing 15,000 and 17,000 lbs., respectively, were received from Allegheny Ludlum Steel Corp. W-G then produced exhaust-nozzle and adapter forgings of 72- and 14-in. diameters. Hastelloy X ingots weighing more than 10,000 lbs. were supplied by the Stellite Div. of Union Carbide. A third Hastelloy part was forged as a 50-in.-dia. ring. The stainless steel components will be used in pilot runs to determine the design details in constructing the nozzle units. All forgings were made for Aerojet-General Corp. and will be used in ground tests of the Phoebus reactor.

SPACE MEDICINE

Acceleration Produces Brain Temperature Rise

Soviet scientists report that the temperature of the cortex of the brain in animals changes under the influence of acceleration, which may have a bearing upon the activity of the brain during spaceflight. In the book *Influence of the Factors of Space Flights on the Function of the Central Nervous System,* issued by the Soviet Academy of Sciences, instrumented rabbits were placed on centrifuges to determine the degree of temperature change. A rise of 0.1 to 0.2 degree was attributed to compensatory processes evoked by changes in blood circulation in the brain.

No Calcium Loss in Immobilization Test

Air Force scientists at the School of Aerospace Medicine have been surprised to find that monkeys immobilized in plaster casts for periods of four weeks did not suffer calcium losses, as had been presupposed. On the basis of the results, they called for a re-evaluation of the concepts of the possible effects of hypodynamic conditions on calcium metabolism. The most dramatic change was a loss of nitrogen, but this was attributed to changes in physiological processes resulting from inactivation and not from a decrease in digestive processes or intestinal absorption.

Part I: Survey

Military Set To Face Key Space Tests

by Michael Getler

WASHINGTON—The U.S. military space program is now on the firmest footing it has ever known.

Despite the fact that the Fiscal Year 1967 budget request for military space activities shows a slight decline from the current year's level, there is widespread agreement within the military services and Dept. of Defense that the program has matured greatly in the past year and is now ready to undergo the most meaningful tests of its ultimate utility.

Within the past several months, in particular, programs of great potential importance have begun to move from concept to development schedules. In the area of unmanned flight, these include new multiple-purpose satellites, tactical communications satellites, and range-data relay satellites.

Most importantly, the past few months have seen the most extensive effort made to date to get the Air Force's *Manned Orbiting Laboratory (MOL)* program firmly into the development cycle.

There is, by all estimates, at least a $400-million growth in the U.S. military space program between FY 1967 ($1.6 billion) to FY 1970 (M/R, March 14, p. 9). Whether or not it levels off at roughly the $2 billion annual spending figure depends almost entirely upon the *MOL* program and what the first round of manned flights reveals about the role of the military man in space.

Though the number of other programs soon to move into development represents continued good business for the industry, *MOL* is the determining factor in whether or not the military segment of national space expenditures will ever expand significantly beyond its current percentage of the budget.

Success or failure of *MOL* will be the principal influence upon: development of logistics/ferry vehicles to service military stations in orbit; new, larger boosters; a potentially enormous array of spaceborne command and control sensors, communications, and data processing equipment; expansion of military launch complex and range facilities; and a variety of space-based inspection and defensive schemes now getting a serious second look.

Furthermore, there is good reason to suspect that the Navy's participation in *MOL,* though very much in the background, could turn out to be most significant. Ocean surveillance experiments to be carried out are highly classified and very sensitive. Observers believe the U.S. may be nearing a breakthrough in space-based submarine surveillance.

MOL slippage problems—When Secretary of Defense Robert McNamara announced establishment of the *MOL* program in December, 1963, coming on the heels of the cancellation of the *Dyna-Soar* project, it was estimated that the first manned *MOL* launching would take place late in 1967 or early 1968.

Latest estimates place the earliest possible manned flight in late 1969, still more than three years away. The prospect of the program slipping into 1970 is easy to envision.

DOD's problem during this 3-4 year hiatus before it has the first results on *MOL* is to keep the industry interested. "We want to keep it enthusiastic," one high-ranking DOD official told M/R, "but we don't want to overstimulate it right now."

Even without generating hardware for follow-on missions, the frequency of the manned *MOL* flights, which officials told M/R will cost $50-60 million each, will have a considerable impact on the space budget. In an operational program, these flights could occur as often as every two months in the early 1970's.

Other factors—In addition to the new programs now moving into more clearly defined development objectives, there are other reasons why the U.S. military effort is on more solid ground.

The *Titan III-C,* though it has had upper-stage troubles on recent flights, is solidly in the inventory. Its growth to carry payloads of upwards of 50,000 lbs. into low-Earth orbit is clearly possible, say Air Force officers.

Also, the demonstration of rendezvous techniques by NASA has made it clear that a considerable increment beyond single-launch capability can be cranked into plans without risking a large unknown.

There is, however, another equally important factor: the considerable strengthening of space know-how within the Air Force.

Strong technical expertise at the highest level came with the appointment of Dr. Harold Brown as Secretary of the Air Force last September. Brown, an early member of Secretary McNamara's team and former Director of Defense Research and Engineering, is expected to lend considerable strength to Air Force proposals which he approves on their route to the Office of the Secretary of Defense (OSD).

Some DOD officials feel that Brown's largest impact on the Air Force thus far was actually made during his last few months at DDR&E when he aided in the definition of two of the service's key new programs—*MOL* and the multiple-purpose satellite.

At the uniformed level, an Air Force Systems Command project known as SPAD (Space Principles, Applications and Doctrine) is now into the second phase of a large and well-planned effort to develop the rationale for the military role in space. The new effort is aimed at working up a host of space operations concepts and then systematically exposing them to the total framework of military R&D, doctrine, and strategy.

As one Air Force officer explains it: "We will attempt to use the same analytical tools which Messrs. Enthoven (Assistant Secretary of Defense for Systems Analysis) and Hitch (former DOD Comptroller) have used to shoot us down in the past to justify some of these new programs."

Funding breakdown—DOD funding priorities over the next few years will show alterations from the current breakdown.

U.S. AIR FORCE

Goodyear Aerospace Corp. engineer examines PRIME SV-5D lifting body built by Martin Co. and decelerating Goodyear ballute.

Manned spaceflight, on the basis of expected FY '68 and '69 requests of $400-500 million each year for *MOL* (including some of the funding for the seven-segment strap-on version of *Titan III-C),* should show substantial increases from current levels.

The manned spaceflight portion of spending should be further buttressed in about 2-3 years by a decision to move ahead with a re-usable lifting-body spacecraft.

While it is not yet clear to what extent NASA will be involved in this project, if *MOL* continues to look promising, a re-useable spacecraft for ferry and logistics purposes will unquestionably enhance the cost-effectiveness of whatever is left in orbit. Both Air Force and DOD officials see a go-ahead as likely in the late 1960's.

Long-range Air Force planning in this area envisions a vehicle large enough to carry perhaps 16-20 men to stations in perhaps five different orbital planes, exchanging crews and supplies during a 5-7-day mission, and then returning to a land recovery site.

Furthermore, industry can be expected to be brought into DOD plans for development of space escape systems within the next six months.

Space defense—Space defense, which went through a high interest and spending cycle several years ago but has since dwindled, is expected to pick up again.

Within the next 2-3 years, DOD officials believe that the U.S. will move to deploy a second-generation, ground-based anti-satellite system. The intent reflects no increased U.S. concern with an orbital weapons threat, rather the ability to respond in kind to any Soviet system interfering with U.S. satellites.

Furthermore, Air Force officers, on the strength of growing U.S. booster capability, are expected to press the case for re-opening some of the space-based ballistic missile defense schemes—using boost-phase and mid-course intercept—which were studied several years ago and dropped as too costly and complex.

Satellite inspection or immobilization from space, a dead issue now as an independent project at all but the study level, may also be re-opened by *MOL,* either through maneuvering of the *Gemini-B* or with a remote maneuvering unit.

Unmanned satellites—Funding for unmanned satellites can also be expected to increase.

DOD SPACE AND SPACE-RELATED PROGRAMS

(By Fiscal Years in Millions)

	1963	1964	1965	1966	1967
Manned Space Flight	131.8	89.7	47.0	152.0	158.7
Communications	35.4	80.2	25.7	53.9	62.3
Navigation	42.1	27.9	27.6	17.7	20.9
Spaceborne Detection	102.4	61.5	50.4	59.9	46.0
Space Defense	40.9	66.9	32.1	9.0	10.1
Vehicle & Eng Development	286.1	389.8	274.4	199.1	103.0
Space Ground Support	167.7	171.9	235.1	239.2	268.2
Supporting Rsch & Develop	174.3	157.9	167.1	155.5	157.1
General Support	569.2	553.5	713.0	807.2	794.4
	1549.9	1599.3	1579.4	1693.5	1620.7

High-ranking Air Force officers told M/R that the unmanned programs are now in excellent shape—both financially and technically.

Program 461, formerly the *MIDAS* ballistic missile early warning satellite, has remained in R&D and has yielded excellent progress in sensor development. The program will now be expanded into a real-time data transmission, synchronous-altitude, Integrated Satellite System, Program 266. Development effort is pegged at between $70-100 million.

As a follow-on to ISS, DOD is expected to ultimately move to a more refined multiple-purpose satellite which officials speculate could carry with it a development cost of between $100-150 million.

The largest spending increase in the unmanned area will come with communications satellites. High Air Force officials speculate that satellites used for tactical military communications alone will account for $100 million in annual funding for several years.

Launch vehicles—Launch vehicle development funding is expected to continue to decrease as the *Titan III* emerges further into operational status.

New funds will be applied to the seven-segment solid motor strap-on development for *MOL,* and also probably to a two-or-three segment version. However, these costs should amount to only a fraction of what has been a $900-million *Titan III* development effort. Additional improvements to the core vehicle, and added purchases of the *III-C* version, are also expected to account for some funding.

The best potential for changing the trend in launch vehicle funding over the next few years rests with the 156-in.-dia. solid-motor development. DOD and some Air Force officials see no need for the 156-in. for the next several years. However, there is strong disagreement on this at the higher levels of the uniformed Air Force.

Officials say that payloads larger by a factor of two or three than those that can be handled by the seven-segment *Titan* could be handled by rendezvous rather than new engine development.

The Air Force doesn't see it that way, and is hedging its bet in the new *Titan* launch facility at Western Test Range. Though designed for the seven-segment version of *Titan*, the site is laid out so that it could be easily expanded to handle the 156-in. if the Air Force wins the battle or if DOD sees a need within the next few years.

The *Titan III-C* complex at Eastern Test Range can be increased to handle another *III-C* launch pad, but cannot be readily adapted to handle the 156-in. "We are smarter now," says the Air Force.

Linked to Air Force interest in new space-based interceptor platforms is interest in NASA's *Saturn V*, says one general—"if the cost can ever be brought down." The space agency booster can place 250,000 lbs. in low-Earth orbit at a cost of about $100 million per launch (based on production of six per year).

Some potential is also seen in use of *Minuteman I* ICBM's, now being replaced by *Minuteman II* missiles, as space boosters. DOD officials say the project remains mostly in-house at this point but that studies are due to be completed within the next few months. If results of the in-house effort show the project to be feasible, industry is expected to get RFP's shortly thereafter to pin down some of the engineering details and costs.

Technology hard to sell—Supporting R&D within the military space budget may also dip slightly in relation to the total spending figure. It is, in the view of high-ranking Air Force officers, the hardest item to sell to DOD. There are indications that this view is shared within the higher levels of the DOD.

Testifying before the House Armed Services Committee on the FY '67 budget request for research, development, test and evaluation, DDR&E Director Dr. John S. Foster, Jr., said: "Our review this year was so intensive as to leave much less flexibility than in FY 1966, and hence our ability to cope with unforeseen eventualities during the coming year from within available resources will be limited."

The total departmental RDT&E request originally sent to OSD, covering all defense activity, was reduced by the Secretary by $1.2 billion.

Rationale—While space poses a tremendous challenge to military planners, in terms of the almost unlimited imagination which can be applied, it remains very hard to "get a handle on."

Empirical data on which to base future needs or postulate future threats —plentiful for more conventional warfare—is very scant in the space field. Systems analysis techniques, so successfully applied to the ballistic missile exchange of a spasmodic nuclear war, do not work as well when vaguely perceived threats from an unpredictable enemy are added.

The Air Force, after early years in which enthusiasm admittedly exceeded sound planning, is now keenly aware that space planning must be put on a firmer basis, that new techniques must be developed to replace the missing empirical data, and that the evolution from concept to feasible program recommendation must be made within the total context of military strategy and competitive ways of doing a job.

From what has already been learned through experience and justifiable extrapolation, space is a very good medium to support some military operations—in particular, the gathering of surveillance and early-warning data from either very-low-altitude or synchronous-altitude orbits. It is not difficult to extend this into manned spaceborne command posts, probably with a crew of four, at synchronous altitude with on-board capability for stationkeeping and evasive action.

Such a system would provide real-time reconnaissance, could do on-board data sorting, might be used for crisis management where rapid data on a breaking situation is needed, could supply post-attack reconnaissance, or could be tied into a space-based inter-

Congress Voices Strong MOL Support

The *Manned Orbiting Laboratory* appears to hold highest priority in terms of Congressional approval of military plans and programs. The strong support that the program has appears to traverse party lines and is unanimous in both House and Senate.

Though Vietnam funding is putting pressures on many research and development programs, the space programs hold a strong appeal to most Congressmen. Should any space program suffer, in fact, most of the legislators feel that the civilian space agency should receive the first trimming.

As an example of the feeling about *MOL*, all committees involved in defense—Armed Services and Appropriations committees of the House and Senate—last year wrote specific language into their bills stipulating that the $150 million earmarked for *MOL* in Fiscal Year 1966 could not be spent on another program.

The same clause has been written into the House Armed Services bill this year. As additional evidence of this committee's support, it has voted to ensure that the Air Force gets the additional $80 million which it requested from DOD for *MOL*.

While the Senate, which has already voted on the bill, did not add this money, it is understood that should DOD make a case for it, it would be forthcoming.

There has been criticism in the past that DOD has been too secretive about its activities, particularly with respect to the *MOL* program. Committee members now feel that the recent classified sessions elicited adequate information for the policy decisions they must make.

The *MOL* secrecy problem has never been as acute as that in such controversial areas as the manned bomber program, the nuclear Navy, or military base closings, they add. Most dissatisfaction with DOD answers occurred during the long period in which the *MOL* program was delayed.

Full support also has been given by the Congress to the highly classified military reconnaissance space programs. While there have been some anguished cries behind closed doors about the cost of maintaining these programs, they have been accepted with the feeling that such an outlay is the inescapable price of highly technical and advanced protection.

The return from these programs justifies their cost, the committee members feel. And though there is a great deal of new emphasis on R&D for Vietnam, there is no loss of support for the existing programs —or loss of sight of the threat from a more sophisticated enemy.

The airplane that is made for this kind of fighting is called the F-5.

NORTHROP

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ceptor platform.

Other supporting roles in communications and navigation are also easy to envision as continually expanding.

However, other areas are less clear —particularly the area of weapons offense and defense.

Start with SPAD—Within the Air Force's SPAD program, the Air Force, and industry in some phases, have combined in an effort to fully explore the prospects of the space environment during the 1972-85 period.

The effort started in February, 1964, with a first phase aimed at development of the technical fundamentals. A comprehensive Space Planners Guide resulted, and was published last September.

Phase II began last November and is expected to be completed in about a year, though some preliminary results are expected to be in hand later this summer. This second phase is the key to the follow-on Air Force space program. It is an attempt to generate concepts and put them to the test against all things which may impinge upon their credibility.

The concept, or search, stage allows postulation of ideas with maximum freedom. For example, contemporary constraints imposed by budget, technology, or test-ban agreements, for example, are disregarded. The search stage is heavily aimed at sparking the Air Force in-house talent, but also calls upon a variety of industry-generated concepts.

Air Force officers report that more than 70 detailed conceptual packages have already been submitted.

They range from refined command and control and surveillance platforms, to some admittedly far-out possibilities, such as: a satellite interceptor system based in a C-5A aircraft, a variety of manned offensive and defensive systems powered by Van Allen belt radiation, nuclear-powered ferry vehicles, environmental-control and Earth-illumination satellites, orbital weapons programs, and even a "Doomsday Machine" linked to an asteroid belt explosion.

From the concept stage, design packages are fed into a data bank already in being at Air Force Systems Command for storage and retrieval. The data is subsequently analyzed by a series of panels which cuts across all major Air Force commands and technical disciplines.

Air Force Maj. Gen. Jerry D. Page, under whose command the SPAD group works, sees the Fundamental Space Operations Study as, "under no circumstances the end of our search, but a pioneering effort of major significance in the realm of aerospace theory." ■

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This Rohr-built, three-million-pound-thrust, first stage nozzle is composed of a steel outer shell and tape-wrapped plastic liner. The nozzle throat is lined with ablative or "burn-away" plastics designed to withstand the 5700-degree (Fahrenheit) temperature and supersonic flow of exhaust gases by gradual vaporization of its surface molecules. After wrapping, the ablative segments were cured and densified in our 176-inch diameter hydroclave and machined to fit precisely the steel nozzle shell. Additional reinforcement was provided on the exit cone by application of sections of aluminum honeycomb and filament wound fiberglass.

This 35-foot-long, 156" diameter second-stage motor case employed portions of two previously fired segmented cases. They were cut and welded to form the monolithic case at a savings of more than 50 percent. This "re-use" procedure also gave the Air Force the opportunity to gain new information on 18 percent nickel maraging steel, the tough new alloy being adapted to large solid rocket motor use for the first time in the 156-inch motor program. Rohr became a logical choice for this work because of its large equipment and experience in machining and welding maraging steel.

Rohr employed a combination of maraging steel, filament wound fiberglass, aluminum honeycomb and ablative liner materials in the fabrication of the submerged, liquid injection thrust vector control nozzle for the 21-foot filament wound third stage motor. Honeycomb was used to add structural stiffness to the exit cone. Tape-wrapped carbon, graphite and silica were employed in the ablative liner. A new "rosette" fiberglass layup technique was used for the first time.

For additional information concerning the Rohr space products capability contact: Marketing Manager, Dept. 69, Space Products Division, Rohr Corporation, 8200 Arlington Ave., Riverside, California.

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Cryogenic Engine Is Latest DOD/NASA Joint Project

WASHINGTON—Defense Dept./NASA space program coordination is currently highlighted by joint efforts in the development of a new, powerful cryogenic engine and the modification of a jet engine for air-breathing propulsion research.

The cryogenic engine will be covered in a new agreement between the two agencies expected to be signed in about two months. It will reportedly provide for building a breadboard liquid-hydrogen engine with a thrust of 200,000 to 500,000 lbs.

Adm. William F. Boone, Assistant NASA Administrator for Defense Affairs, also told MISSILES AND ROCKETS that the space agency's Lewis Research Center would modify a J-85 jet engine for use in air-breathing technology development. As its portion of the joint program, the Air Force will provide an F-106 aircraft for flight tests of the engine.

The yield—Other results of the space coordination effort:

—The first report of the joint lifting body-re-entry program is due July 1. In addition, flight tests of two NASA and one Air Force lifting body vehicles are scheduled to begin in the near future. Both NASA and Air Force pilots will take part.

—About seven high-level NASA officials are being assigned to top jobs in Air Force space programs. Five or six will be involved in managing the *Manned Orbiting Laboratory (MOL)* project and two others are expected to be assigned to Holloman AFB, N.M., where they will work on studies of advanced manned programs, including such things as reusable boosters. At the same time, the number of DOD personnel assigned to the space agency has grown to 330.

—A research and technology national exchange has been set up so that the technologies developed by both agencies are contained in one data bank and are available to each and also to other Government agencies. The NASA branch is at Langley Research Center and the DOD portion at the Defense Documentation Center.

—NASA is making some "$25 million worth of equipment considered surplus in the *Gemini* program" available to the Air Force for use in the *MOL* project. This includes simulators and astronaut training facilities and equipment as soon as they are released from *Gemini*.

—The Air Force is making space available on the *MOL* flights for NASA experiments and the space agency definitely plans to fly some on the long-duration missions. Just what experiments will be selected depends in part on when the seven *MOL* flights will be made.

Adm. Boone and a high-ranking Air Force officer both expressed satisfaction with the way coordination between the two agencies is being carried out.

The NASA official said this does not mean that occasionally the viewpoints of the two do not differ. He pointed out, however, that the National Space Act provides that when the two fail to reach an agreement, an appeal can be made to the President. Thus far there have been no appeals. "We have always been able to work out our problems with the administrative machinery we have," he said.

Coordinating Board—The biggest of the coordinating bodies is the Aeronautics and Astronautics Coordination Board (AACB).

The board is headed by Dr. John S. Foster, Jr., Director of Defense Research and Engineering, and Dr. Robert C. Seamans, Jr., Deputy Administrator of NASA.

Members-at-large from NASA include Adm. Boone, DeMarquis D. Wyatt, Assistant Administrator for Programming, and Dr. Homer E. Newell, Associate Administrator for Space Sciences and Applications.

DOD-at-large representatives are Dr. Alexander H. Flax, Assistant Secretary of the Air Force for Research and Development; Dr. Thomas F. Rogers, Deputy Director, Electronics and Information Systems, DDR&E; and Daniel J. Fink, Deputy Director for Strategic and Space Systems, DDR&E.

The board primarily handles liaison between the two agencies. It also decides what programs should be undertaken jointly and what the responsibility of each agency should be in a given project.

Its panels—It is aided by six panels. The Aeronautics Panel is chaired by Rear Adm. Noel A. M. Gayler, USN, Assistant Chief of Naval Operations. The vice chairman is Charles W. Harper, Director of Aeronautics in the space agency's Office of Advanced Research and Technology.

The chairman of the Launch Vehicle Panel is Dr. Flax. The vice chairman is Milton W. Rosen, Office of Assistant Administrator for Defense Affairs.

The Manned Space Flight Panel is headed by Dr. George E. Mueller, NASA Associate Administrator for Manned Space Flight. The vice chairman is Dr. Flax.

The Space Flight Ground Environment Panel is chaired by Brig. Gen. Clifford J. Kronauer, USAF, Assistant Director, Ranges and Space Ground Support, DDR&E. The vice chairman is Edmond C. Buckley, Associate NASA Administrator for Tracking and Data Acquisition.

The Supporting Space Research and Technology Panel is headed by Dr. Mac C. Adams, NASA Associate Administrator for Advanced Research and Technology, with Dr. Chalmers W. Sherwin, Deputy Director, Research and Technology DDR&E, serving as vice chairman.

The Unmanned Spacecraft Panel is headed by Robert F. Garbarin, Deputy NASA Associate Administrator for Space Sciences and Applications, with John Kirk, Assistant Director for Space Technology in DDR&E the vice chairman.

The AACB meets every six or seven weeks.

Other panels—Two new panels have recently been set up outside the AACB. One is the Joint Manned Space Flight Policy Committee, which is composed of the top officials in the *Apollo, Gemini* and *MOL* programs. They weigh top policy decisions affecting these programs.

The other is the Manned Space Flight Experiment Board, which is charged with determining what experiments will be flown in the manned program.

In addition to these bodies, NASA and DOD have set up 40 additional groups to handle various types of coordination and there are over 100 NASA/DOD agreements covering various joint programs. ■

PART II: PROGRAMS

Manned Spaceflight

Future Programs Considered Hinged to MOL Performance

by Hal Taylor

WASHINGTON—Defense Department officials do not believe a decision on the need for an advanced manned military spaceflight program will have to be made for at least three years.

Their position is based on the belief that a new program should not be initiated until *Manned Orbiting Laboratory* astronauts have proved that man can add to this country's military space capability in Earth orbit.

This view is not shared by some Air Force officers who feel that plans for advanced programs do not necessarily have to wait until early systems have been proved in flight tests. But it is clear, following talks with both DOD and the Air Force, that no one in the defense establishment is pushing very hard for an advanced manned program beyond *MOL,* with the possible exception of a reuseable spacecraft for logistics and ferry purposes.

This is not true, however, as far as an operational *MOL* program is concerned. A high-ranking Air Force official reports that though there is no approved *MOL* program beyond the planned seven-flight R&D effort, "we wouldn't have started the program if we didn't have plans for an operational system."

Where the action is—While consideration of a new, large post-*MOL* manned program is currently in limbo, there is activity in other areas of the manned military space program:

—The Directorate of Defense Research and Engineering expects to issue requests for proposals in about six months to industry for development of a space rescue capability.

Within DDR&E, the preponderance of opinion holds that the best hope of developing such a capability lies in providing Earth-orbiting astronauts with an escape capability that will allow them to leave their spacecraft and return to Earth on their own rather than having rescue spacecraft launched from the Earth.

—The Air Force envisions the need for a lifting body resupply vehicle in the mid-1970's. As a result, development of such a vehicle may be initiated in the late 1960's. DOD officials generally concur in the need for this vehicle. They are now attempting to pull together much of the on-going work and develop a schedule for further orderly development.

—The Air Force has asked NASA to provide two more spacecraft from its *Gemini* program for use in unmanned *MOL* missions. This brings the total to four spacecraft transferred from the space agency to DOD.

One of the new spacecraft will be used in a pad abort test. The Air Force, M/R has learned, is experimenting with a new escape system in which the spacecraft's retro-rockets could be used for pulling the capsule clear of the launch vehicle in case of a pad abort, with the pilots then using the ejection seats.

The other will be used as the payload on an R&D flight test of the seven-segment *Titan III-C* launch vehicle.

—Air Force officers have reported that, to the greatest extent possible, subsystems developed in the *Gemini* and *Apollo* programs will be used in *MOL.* The latest to be incorporated into the program is the extravehicular space suit used by *Gemini* astronauts.

Though the Air Force will use existing life-support systems in its early manned program, it is pushing for technological improvements to meet its own needs. One example is modification of the *Apollo* Lunar Excursion Module (LEM) environmental controls system, developed by Hamilton Standard, to make it a two-gas system, and the study of helium as a diluent gas for possible weight savings.

—Studies will begin in Fiscal Year 1967 on advanced subsystems for manned spacecraft. Initially, DOD officials say, attention will be focused on integration of advanced space power systems with new guidance and control technology within the overall spacecraft system.

MOL plans—The Air Force is negotiating with NASA for the acquisition of two more *Gemini* spacecraft. An official announcement is expected later this summer or fall.

The Air Force wants the *Gemini 9* capsule, which is scheduled for a three-day mission this week, and *Gemini 10,* which is scheduled for launch later this summer, probably because these craft have the latest technical changes—including a switch that can shut down all 16 thrusters in the orbital attitude maneuvering system (OAMS).

After the spacecraft are turned over to DOD, it is expected that the McDonnell Aircraft Corp. will receive a contract to refurbish them. The pad abort test and the launch vehicle flight test are expected to follow the heat shield flight test, using *Gemini 2,* which will be the first launch in the program.

Two unmanned flight tests using *Gemini-B* spacecraft—built for the *MOL* program by McDonnell—and five manned flights, will then be made.

It now appears that the first unmanned flight has slipped into 1969 (M/R, April 18, p. 14), and the earliest date for a manned shot now is the last half of 1969 (M/R, May 9, p. 13). That target date could slip even further if the Air Force does not receive a desired $80 million in additional FY '67 funding for the program. While this has been recommended in Congress, there is no certainty DOD will let the Air Force use the money.

Momentum mounts—High-ranking Air Force officers feel the *MOL* project—which has suffered many delays since its inception—is now on very solid ground. They believe that DOD has made a strong commitment to the program and that it will proceed into the development and flight phase.

Top Air Force officials feel that *MOL* manned flights at first will be made at the rate of about one every four months or so. Later, as more flight experience is gained, this may increase in the 1970's to a rate of perhaps one every two or three months. It is not foreseen at this time that *MOL's,* even in an operational program, will be launched at a more frequent rate.

Limiting factors on the launch schedule are the high cost per launch, the turnaround time for launch and ground support facilities, and U.S. Navy support required for water recovery of the *Gemini-B.*

DOD and the Air Force report they have no present plans for land recovery of the *MOL* spacecraft despite the fact that the use of its forces for recovery is a serious problem for the Navy. The problem will be even more intense in 1969-1970 because long-duration Project *Apollo* missions will also be taking place.

There is at least a possibility, admittedly remote, that the Air Force may suggest attempting to snatch the *Gemini-B* out of the sky during re-entry using the same methods developed for its *Discoverer* unmanned satellite series. Informed sources report that the airplane/skyhook recovery system developed for that program was man-rated and is available for use in the program.

Astronaut Maneuvering Unit undergoes zero-g simulation test in KC-135 aircraft.

The planned *MOL* polar orbit, ranging from an apogee of 150 n. mi. to a perigee of 100 n. mi., is especially good for *MOL's* primary surveillance role. In addition, because of its polar orbit it will pass over every area of the Earth once a day.

While the whole program is classified, ocean surveillance techniques appear to be especially sensitive. This indicates that this country perhaps has achieved a sharp breakthrough in anti-submarine warfare that will be tested aboard *MOL.*

Though *MOL* funding requirements started slowly in FY '66 and '67, both DOD and the Air Force expects it to reach its peak in FY 1968 and 1969 when a budget level of $400 million to $500 million a year is expected.

One method the Air Force has used to hold down *MOL* costs is the very extensive use of subsystems developed for NASA's *Apollo* and *Gemini* programs.

Experienced team—Douglas Aircraft Co., prime contractor for *MOL,* has already selected such firms as Honeywell, Inc., for the guidance system, Collins Radio for communications, and Pratt & Whitney for fuel cells (M/R, April 4, p. 15). Hamilton Standard Div. of United Aircraft Corp. was also named to develop the environmental control system. All these firms developed similar systems for *Apollo.*

DOD has not named a contractor for the *MOL* navigation system and presumably will build it in-house. Air Force officers stress that this approach does not indicate any problem with this subsystem. "If there were concern over this, we'd have a contractor," says the Air Force.

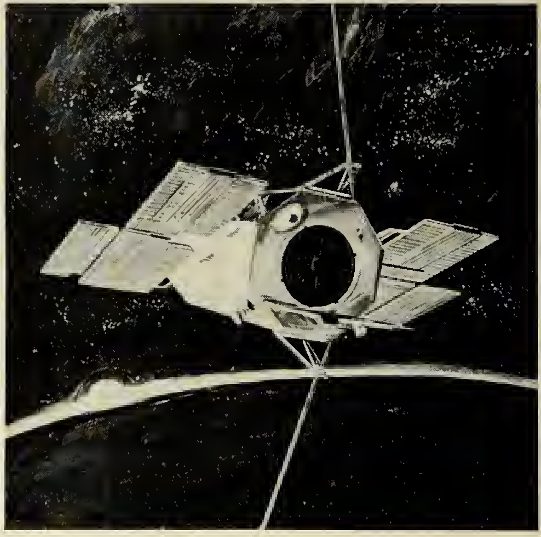
Also to be selected is either IBM or Sperry Rand for the data-management subsystem. Decision was expected in May but now reportedly has slipped a few weeks.

All other industry cost submisisons were due at *MOL* headquarters at the Air Force Systems Command this month. The program is expected to move out of the definition phase and into early development within the next few months.

One of the prime purposes of the *MOL* mission is to discover the role of man in the vehicle, and one of the areas receiving particular attention at Aerospace Corp. and other organizations connected with the program is the nature of the man-machine interface, and the effect the presence of a man has on system design.

Computer details—On the launch pad, the *Titan III, MOL* and the *Gemini-B* spacecraft will contain an impressive complement of computers. The *Titan III* computer for this mission will have a random access memory instead

this 22,000 part stabilization system



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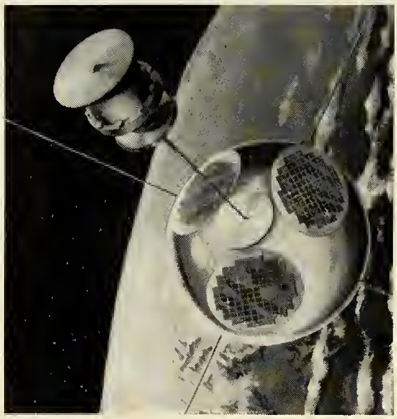

will have a lot hanging in the balance.

OAO and MAGS for example . . . with Nimbus, GGTS, and ATS somewhere in between. Which may give you some idea of how flexible our approach to space engineering is. To achieve the exceedingly accurate pointing requirements of the Orbiting Astronomical Observatory, we came up with a 22,000 part active control system which uses tiny rockets, gas jets, and thousands of electronic and mechanical parts to position the spacecraft and keep it there within one-tenth of a second of arc. Our Gravity Gradient Stabilization System, on the other hand, is a passive system with few moving parts and uses no power for operation, utilizing the earth's natural gravitational field to make a satellite constantly point to the earth to within two degrees of arc.

Our spacemanship is equally dexterous in other areas. SNAP-27 will be the first nuclear power system for operation on the surface of the moon. SPET (Solid Propellant Electric Thruster), with no valves, no moving parts, promises to be extremely valuable for increasing the reliability of active attitude control systems. In the important area of manned vehicles, we're working as a prime contractor on MOL. And we're studying a Voyager to go to Mars. Beyond that, we have ideas that haven't even reached the drawing boards yet.

If you have ideas on the subject, look into these opportunities: nuclear power, nuclear chemistry, thermionics, environmental control, IR/optics, simulation, human factors, life support, structures and weights, reliability, guidance & control, measurements and environments, materials development, spacecraft design.

Write in confidence to Mr. J. S. Barson, Dept. 394E-3, Valley Forge Space Technology Center, General Electric Co., P.O. Box 8555, Philadelphia, Pa.

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of the drum memory hitherto used, and will consequently have much greater flexibility. The *Gemini* flight computer will function as backup to the *Titan III* computer, and will be modified for inertial guidance rather than radio guidance. The *MOL* itself will have a general-purpose computer aboard, which may be used to assist the astronaut decide which of the two navigation computers is giving the most reliable data.

Once in orbit, it will be important that the full powers of the general purpose computer are available to the astronauts and a capability for a "conversational" interaction with the computer is likely to be included.

There is some doubt whether cathode ray tube displays will be suitable for *MOL*. The tubes deteriorate in the helium atmosphere with inward diffusion of this gas. However, the CRT's ability to display rapidly changing data may not be required and an electric typewriter may prove quite adequate as an input-output device.

Lifting bodies—One phase of future manned spaceflight receiving close scrutiny by both DOD and Air Force officials is the use of lifting vehicles as logistics carriers and re-supply vehicles for large Earth-orbiting spacecraft.

Both agencies believe a decision on a lifting body design and some sort of go-ahead for development can be expected in about two years.

As part of that timetable, DOD and NASA signed an agreement calling for a joint lifting body research program six months ago. In it, three different vehicle designs will be glided back to Earth by pilots of both agencies after launch from a B-52 bomber.

The flight series, featuring NASA M2-F2 and HL-10 vehicles and the Air Force's SV-5, is scheduled to begin in the near future. In addition, both agencies are engaged in large efforts to find out what types of technologies will have to be developed to make lifting body vehicles feasible (see p. 76).

Space rescue—DOD's intention to get industrial participation in its space rescue program studies in about six months indicates the seriousness with which it is being considered. Several firms have already offered unsolicited proposals on systems they would like to develop.

DOD officials now believe that some sort of escape system that would use a small capsule with a heat shield to return an astronaut to Earth safely is perhaps the best answer.

Most feel that a real space rescue vehicle will probably have to wait until the development of a lifting body re-entry vehicle.

The problem is also evident at the Air Force's Space System's Div., where broad continuing studies have thus far failed to find a solution.

One study under way in-house, with technical support from Aerospace Corp., is aimed at "trying to get a better insight into the probabilities, what the problem might be, subsystem failures, etc., that might result in a spacecraft being disabled," one source said. "In general, this is not tied to the *Manned Orbiting Laboratory* program. We simply want to gain an idea of what might be the preferred way of attacking the problem. One is by preventive measures—high reliability, integrity, redundancy."

In general, opinion at SSD is split on whether a separate rescue spacecraft or an escape capsule built into a spacecraft would be the solution, with some spokesmen showing little enthusiasm for the subject at all. They point out that even if an acceptable escape capsule could be developed for a spacecraft, astronauts still could be lost, depending on where on the globe they landed and whether recovery forces could find and rescue them. Yet some spokesmen think the escape capsule method holds better possibilities than development of a separate rescue vehicle. This view is also said to be the most widely held at Aerospace Corp.

Proponents of some form of space lifeboat believe such a system could be built into a manned spacecraft with about 600 lbs. added to the complete hardware package.

SSD has reportedly asked that two contract studies be let to further pin down the problem. One would attempt to develop statistics on the likelihood and types of failures requiring escape; the second would call for preliminary engineering design of various escape capsule concepts. ■

Life Support

Air Force To Use Gemini Suit For Extravehicular Operations

by Heather M. David

WASHINGTON—The Air Force has contracted with the David Clark Co. for *Gemini* extravehicular spacesuits, which apparently will be the basic uniform for manned operations in the immediate future.

The Air Force, however, although it has released no details on modifications, has indicated it would like to have a better thermal protection system, as well as less bulky garments, to protect against micrometeorites and radiation.

A number of in-house efforts are in progress at Brooks AFB, Tex., (M/R, April 25, p. 39) on new concepts of cooling and pressurization which might afford better mobility, and a study of the entire field is being put together with recommendations for the future by a contractor for the Aerospace Medical Research Laboratories.

For the time being, however, officials say the *Gemini* suit appears well fitted for some of the repair and rescue and extravehicular experiments the Air Force has in mind. At present there is no specific interest in a hard suit such as that being developed for NASA by Litton Industries, since the Air Force has no mission to land on the Moon or another planet.

The Air Force is still wrestling with the knotty problem of which combination of atmospheric gases to use in the *Manned Orbiting Laboratory*.

A decision on an oxygen/helium atmosphere at 5 psi was nearly firm some months ago, but a series of several hundred experiments on decompression from this atmosphere to the pure-oxygen, 3.5-psi atmosphere which would be used in spacesuit operation has muddied the picture considerably.

These experiments, carried out at the School of Aerospace Medicine by Dr. Thomas Allen and WAF Maj. Sarah Beard, showed that the decompression from helium/oxygen produced even a greater number of bends than did the same pressure-drop ratios from nitrogen/oxygen. However, in spite of the new evaluation of the bends problem, little thought is being given to sticking with the pure-oxygen atmosphere used by NASA for the *Gemini* program.

The environmental control system contract with Hamilton-Standard Div. of United Aircraft includes evaluation of both nitrogen and helium as a diluent.

Regenerative systems—While the Air Force has been a leader in development of regenerative subsystems for life support in space, the day when such a method actually will be used apparently is far distant.

Present thinking is in favor of the resupply of oxygen and other necessities in orbit, rather than regeneration from wastes in a closed-cycle system. Systems currently in design could provide subsistence for 60 days without resupply, Air Force officials feel.

Should a mission have to go six months in orbit without resupply, they feel a tradeoff point might be reached at which a regenerative system should be installed. A number of companies are working on study contracts for various aspects of regenerative systems.

Trace-contaminant control—The materials and trace-contaminant laboratories located at Wright-Patterson AFB, Ohio, will be the center of evaluation of materials for use in Air Force vehicles.

Here, in closed chambers called "Thomas Domes" after their designer, Dr. Anthony Thomas, materials and subsystems can be run at various pressures and in various atmospheric mixtures to determine their exact outgassing properties and possible contamination problems.

While catalytic burners have been suggested for Earth-orbital missions, the Air Force reports that no decision has yet been made on trace-contaminant control, although the problem is recognized and a positive approach will be taken.

Biomedical monitoring—While the Air Force philosophy generally favors minimal monitoring, some physiological research monitoring is expected when longer in-orbit times are achieved.

The Air Force is most interested in monitoring devices which will be the least restrictive and annoying to the space crew, such as the incorporation of electrodes into helmets and other gear.

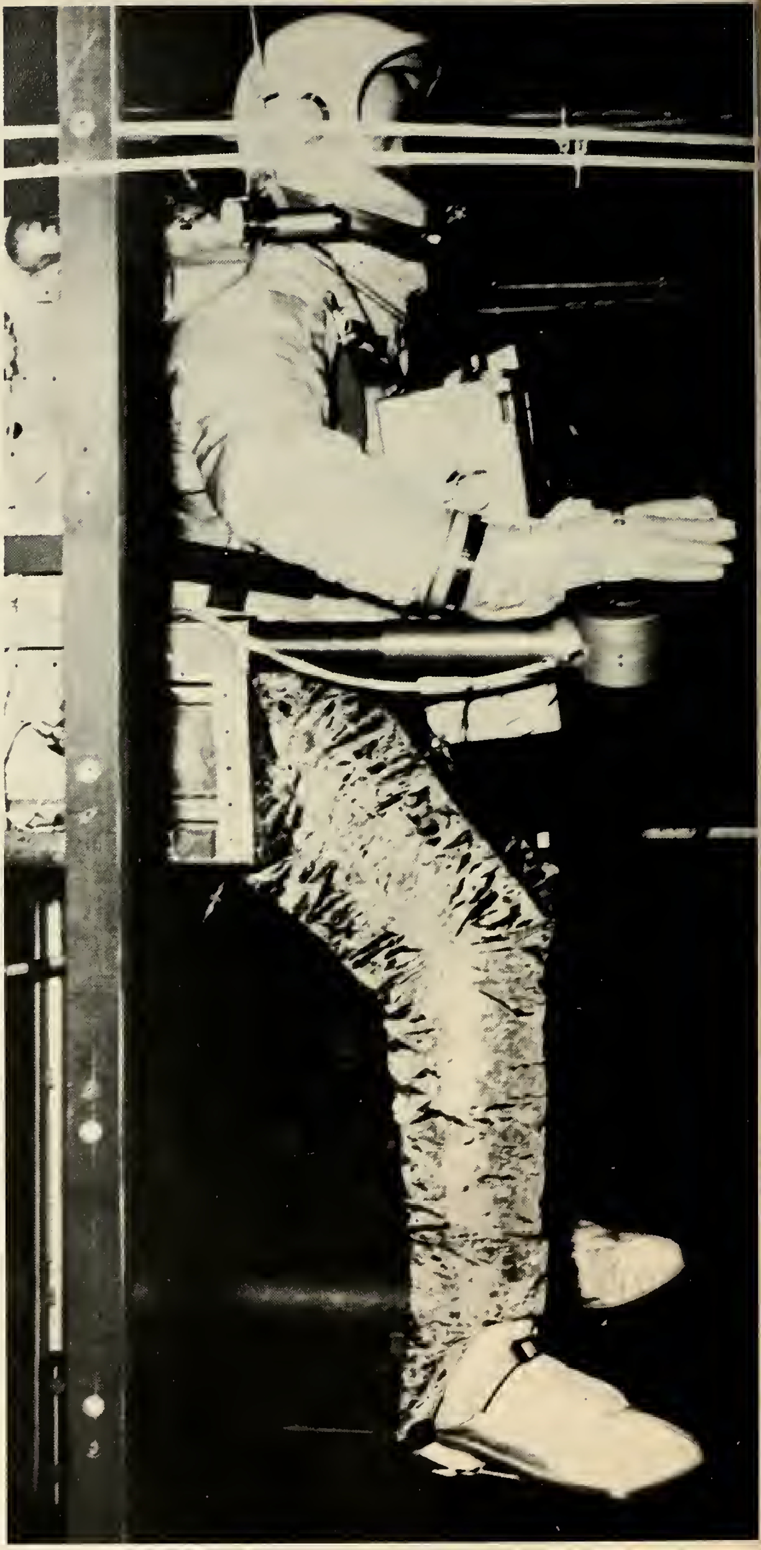
The AMRL labs at Wright-Patterson are developing a cigarette-package-sized electrocardiogram monitor, and other work on microminiaturization is going on at Holloman AFB, N.M., and Brooks AFB.

Parameters expected to be measured include the standard physiological measurements such as electrocardiogram, electroencephalogram, respiration, pulse and galvanic skin response.

Also being examined is the question of biomedical research in the longer missions, including the possibility of chemical analysis of body fluids in orbit.

While the NASA/DOD agreement on the *Biosatellite* largely rules out any experiments on large animals in Air Force Earth-orbital missions, it is very likely that some biologic experiments will be carried, depending upon the state of the art of such experiments and the nature of each mission.

Restraint systems—Current plans are for *MOL* astronauts to sleep in



Pre-test checkout of "iron pants" thermal outer garment developed by Air Force Materials Laboratory at Wright-Patterson AFB. Suit is designed to protect astronaut from 1,200°F gas plumes of the Astronaut Maneuvering Unit's jet thrusters.

hammock-like devices while in orbit, although no testing of such devices has yet been done in weightlessness.

Restraint at the work area is expected to be provided by toe holds and hip restrainers, and various strap devices also are being looked at. The standard *Gemini* couch will be used during re-entry.

Future research—The Air Force is stepping up its efforts in a number of areas in support of space missions throughout its Aerospace Medical Division.

The basic problems of weightlessness—studied through bedrest and immersion—continue to be of prime importance at the School of Aerospace Medicine at Brooks AFB.

Work on decompression, as well as sophisticated psychological and psychometric studies, is being carried out with chimpanzees at the Aerospace Medical Research Laboratory at Holloman AFB.

New emphasis is being put on research on the effects of various areas of the electromagnetic spectrum. While some aspects are classified, it is known that the Air Force is considering use of advanced electro-optical sensors aboard *MOL*, and may also be considering test of a new thermoelectric radioisotope unit under development for the AEC for eventual power supply purposes.

Research on radiation and radiation protection by pharmocological means, shielding and the like, also is receiving emphasis and will be greatly enhanced with the completion of a new bionucleonics laboratory at the School of Aerospace Medicine at Brooks (M/R, Nov. 15, p. 34).

Other research areas of prime importance, AF officials say, are long-range psychological studies on man, the effect of diurnal cycles and lack of an Earth day-night reference on man's ability to work efficiently, and nutrition problems.

Also one of the most important problems, top officials say, is that of waste disposal. What the Air Force would really like to see, officials say, is a disposal unit as big as a cigarette package which would obviate the storing of waste material on long-term missions.

Expansion—While the diversion of funding to Vietnam is affecting the rate of expansion of the Aerospace Medical Division, some new facilities are being planned in support of current programs.

One under way is a new impact facility at Wright-Patterson AFB. It will permit more precise duplication of the exact vibratory stresses which crewmen will undergo in flight, both from booster engine and aerodynamic sources. ■

Unmanned Satellites

New Applications, Techniques Sought for Advanced Systems

WASHINGTON—New unmanned satellites are being considered or are already in development in every military application area.

These include a multipurpose early-warning system at synchronous altitude, a synchronous-orbit observation satellite employing infrared-imaging techniques, global strategic and tactical communications systems, an improved navigational satellite system to permit tactical-forces use, and a national range data-relay system.

Within the services, the U.S. Army is quietly continuing with its highly successful and relatively low-cost *SECOR* geodetic survey system—the only satellite system under Army control. The Navy seeks to improve its Navigational Satellite System to permit tactical use and is expected to retain control of the effort because of its intimate tie to the Fleet Ballistic Missile Program. The Air Force controls all the other present and future satellite systems.

With this responsibility well in hand, Air Force is persistently investigating new space applications and techniques no matter how far-fetched, since so many of today's "impossible" concepts can be the beginning of tomorrow's systems—with the accomplishment of a few breakthroughs in technology.

Typical of the futuristic unmanned system concepts being looked at are a navsat for fighter/bomber operational support, an Earth-illumination (by high-powered lasers) system, orbital weapon-delivery systems, and a variety of surveillance/reconnaissance satellites. The list, compiled from both military and industry sources, is rapidly growing.

The following pages summarize today's systems and those of the near future.

Written by Senior Editor Charles D. LaFond and Associate Editors Larry Curran, Rex Pay and Ron Barnhart.

INTELLIGENCE

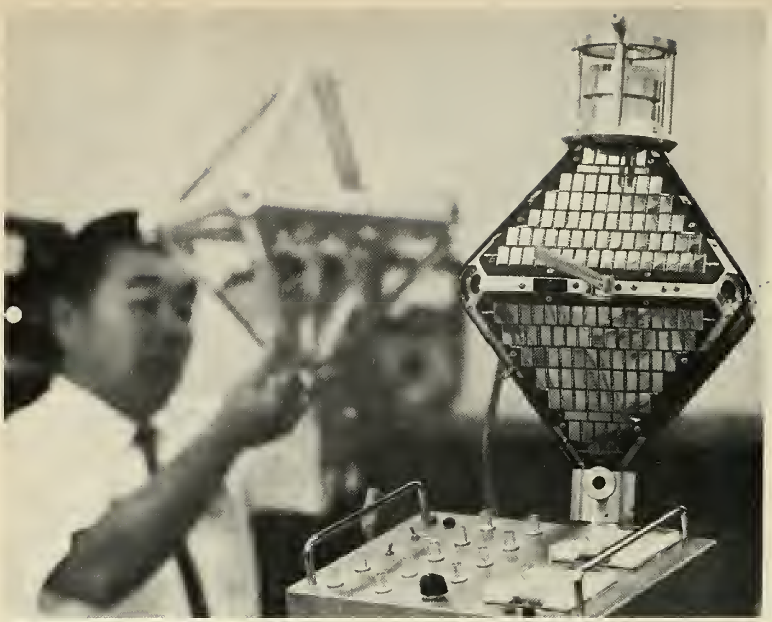
For years, the Defense Dept.'s heavy security mantle has covered its efforts associated with intelligence-gathering satellites. The reasons are its own; the validity for such a complete news blanket is subject to argument. Yet, within recent months, the curtain has been parted slightly with the revelation by DOD officials that a new "integrated" satellite system and a "multi-purpose" satellite system (possibly a follow-on from the other) were being considered for early-warning application.

The new concept, for ultimately combining missile-launch detection with nuclear detection and meteorological data gathering in a single orbital vehicle at synchronous altitude, is largely the result of major technological gains in the development of infrared detection techniques.

The information lid remains tightly sealed on the "ferret"-type RF surveillance systems and on the *SAMOS*-type photo-optical satellites (still considered R&D) employed at lower altitudes in polar orbits. Nuclear detection, for some time more open to public discussion, has been highly successful and probably exceeds all other areas in state-of-the-art advancement as a practical system. Through NASA and Weather Bureau efforts, navsat techniques and hardware are steadily being improved.

Although Air Force spokesmen have referred to the need for a hybrid or multi-function synchronous satellite for well over a year, and have studied improved surveillance satellites (M/R, Aug. 9, p. 12), the first high-level DOD announcement of the reality of such a program requirement was made late in April by DDR&E Deputy Director Daniel J. Fink (M/R, May 2, p. 17).

The multiple-purpose satellite effort encompasses two programs.



OV5 spacecraft was developed by TRW Systems as part of the Environmental Research Satellite (ERS) series. The octahedral satellite will carry one experiment package. The first is expected to involve zero-g heat transfer study. About a dozen ERS satellites have piggybacked on Air Force satellite payloads during the past three years.

DOD has asked industry to propose on a new "Integrated Satellite System," also known as Program 266. It essentially is an upgrading of the *MIDAS* early-warning satellite to incorporate greatly improved early-warning sensors and lift its orbital altitude to synchronous regimes for wider area viewing and real-time data readout. Presumably, other secondary sensing functions will be built into this satellite on a non-interference basis. Program 266 could serve as the basis for a larger and more fully integrated multipurpose satellite to follow in the early 1970's.

Development effort on the integrated satellite, which would weigh about 1,600 lbs., is expected to cost $70-$100 million.

Several firms are expected to respond to the RFP request on 266. Among these are believed to be an Aerojet-TRW team, Hughes Aircraft, and a four-company team headed by Lockheed.

To gather data for the follow-on multiple-purpose program, DOD has also embarked on a project with the Applied Physics Lab of Johns Hopkins University to use a spacecraft, initially intended as a backup for a gravity-gradient satellite launch, as a test bed to gather data on subsystem performance and interaction in a multipurpose design.

The multiple-purpose program would combine early warning, meteorological, and nuclear detection sensors in a single synchronous-altitude satellite program. While these sensors would be integrated, they would also be able to carry out their primary functions in an essentially uncompromising fashion. Development effort for this satellite could cost between $100-$150 million over a 2-3 year period beginning in the late 1960's or early 1970's.

Early warning—Program 266, currently out on bid to industry in a form described by DOD as the TRW/Aerospace Corp. concept, represents a large step forward in satellite early-warning technology.

Considerable sensor and discrimination-system research has been carried out in Air Force Program 461 *(MIDAS)*, with Lockheed as the vehicle contractor and Aerojet-General as contractor for the infrared detection system. The R&D effort, using vehicles orbited at low altitudes, showed that techniques could be devised for detecting ballistic missile exhaust plumes by their infrared radiation.

It also showed that advancements were necessary before embarking on an operational system.

Vehicles orbiting at such low altitudes did not provide a constant surveillance capability. The ideal orbit for this task has always been recognized as the synchronous one.

Fortunately, while sensor and discrimination techniques have been improving, satellite injection to synchronous altitude and subsequent station keeping and communications have been effectively demonstrated in communications satellite programs. The point has now been reached at which development of sensor systems for synchronous altitudes looks attractive.

Recent laboratory tests of infrared target detection systems have demonstrated that suitable resolution and depth of field can be achieved for their operation at synchronous altitudes for detection of ballistic missiles.

Furthermore, the increased payload capabilities of vehicles such as the *Titan III-C* family imply that the systems can also be coupled to sufficient data-processing equipment and data-transmission equipment to yield an early-warning system that will not be saturated by a massive nuclear attack.

The Space-Ground Link Subsystem intended to serve systems such as this has a designed data-transmission capacity from orbit that substantially exceeds the capacity of existing ground receiving stations.

One of the chief capabilities that yet has to be demonstrated for a synchronous early-warning system is stabilization of the orbital payload to the accuracy required for sensors operating at ranges that are more than 100 times greater than those previously used. The accuracy to be expected from horizon sensors is still in question and alternative reference systems are being actively investigated.

Included in these are star-field systems and active gravity-gradient systems. Predictions for the latter type suggest that attitude accuracies of between 0.1° and 0.01° may be achieved. In these systems, the gravity-gradient elements may be continually adjusted to reduce errors, and will form a reference device rather than an actuator.

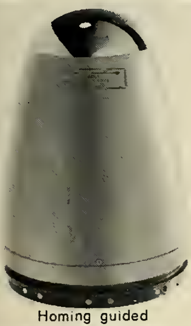
Because the feasibility of the synchronous orbital early-warning system depends heavily on achieving highly accurate stabilization by some means such as this, the *DODGE-M* (DOD gravity experiments, detailed later in this article) experiment at near-synchronous altitude is of considerable importance.

Sensors—Vidicons operating in the two-micron region are available and infrared integrated mosaic detectors with as many as 2,300 sensors on a 1 x 3 in. strip are being produced. One of the chief companies active in the integrated sensor field is Aerojet-General. Sensors of this type, with adequate resolution and data rate, are essential if many missiles are to be tracked simultaneously.

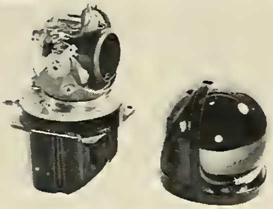
A number of different sensors are likely to be used to provide discrimination between ballistic missiles and other objects. One technique is to use a sensor

INFRARED ENGINEERS AND SCIENTISTS:

Can you contribute to the development of products like these?

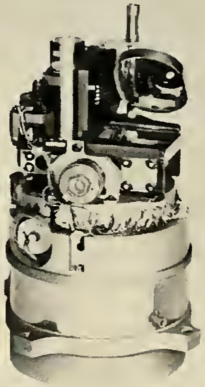


Homing guided missile seeker head.

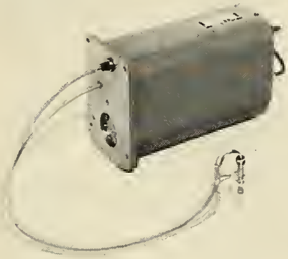


Interceptor IR search/track set.

Anti-tank missile controller.

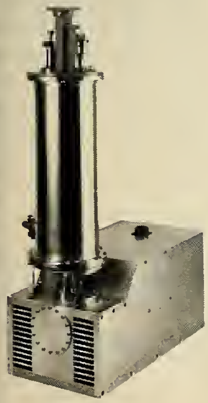


Star tracker for SURVEYOR spacecraft.

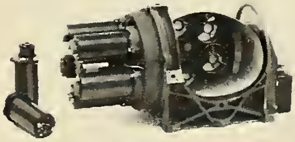


Miniature closed-cycle cryogenic refrigerator.

20-element Ge:Hg detector array.

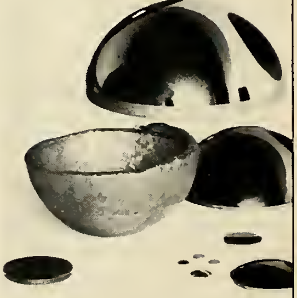


Cryogenically cooled parametric amplifier.



Radiometer for NIMBUS weather satellite.

Multi-element cooled IR detector.



Cast silicon IR optical components.

Rapid growth of Hughes infrared activities in the Aerospace Divisions and the Santa Barbara Research Center has created many responsible positions for qualified engineers and scientists in all phases of IR systems development from conception through production engineering.

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operating on an absorption band (2.7 microns appears to be the most convenient one) so that the missile plume is detected as it comes out of the atmosphere, which masks lower-level sources.

Ultraviolet sensors may be useful for detecting fluorescence from gases surrounding boosters or nose cones after powered flight.

Near-real-time observations—Photographic reconnaissance from orbit provides a superb means for studying one's enemy (and sometimes friend) but it introduces a time delay. Present Air Force photo satellites have been employed at low altitude in polar orbit to successively scan the globe.

Photography from these altitudes provides sufficient resolution to identify principal ground objects and to detect significant landscape change. Photo-capsule air recovery techniques have, reportedly, accounted for as high as 70% successful package return in recent months. The data delay, however, is long. A better answer, if very broad bandwidth were readily available (it is not), is very-high-speed video transmission by digital means to ground terminals. But even this is only a partial solution to the real-time problem.

Because the chief requirement is for a continuous watch over an area of interest, use of synchronous satellites instead of lower-altitude satellites that pass only periodically over a given area is getting considerable attention. The high altitude rules out the use of visible wave-length sensors using conventional optical techniques. Interest is turning toward use of infrared imaging techniques with lower bandwidth requirements.

Nuclear detection—The next two *Nuclear Detection Satellites* (formerly *Vela*), to be launched in December, will be de-spun and will have an attitude-control system to keep them pointing toward Earth. The spacecraft will be 26-sided instead of 20-sided, and the weight will be raised from 500 lbs. to 730 lbs. Use of a *Titan III-C* launch vehicle instead of an *Atlas-Agena* makes this weight increase possible.

The two satellites will be launched into a 60,000-mi. circular orbit. At the same time, an octahedral research satellite will be deployed into a 4,000-60,000-mi. elliptical orbit.

Six *Nuclear Detection Satellites* are in orbit. The two most recently launched are fully operational; the other four are sending some data but have drifted from their optimum orbital spacings.

The long life of the first two pairs of satellites led to inclusion of an electrothermal thruster on the third pair for in-orbit station keeping. A system for adjusting the satellites' spin axes to optimum Sun angles was also included. An experimental sensor for the downward surveillance task was carried in the payload of the third pair as a prelude to the new type of satellite to be launched next December.

The in-orbit incentive payment for the spacecraft contractor, TRW Systems Group, is now adjusted for an 18-mo. orbital lifetime instead of the 6-mo. lifetime stipulated for the first spacecraft.

The first two launches also deployed a small tetrahedral satellite into an elliptical orbit for gathering data on background radiation between altitudes of 100 and 60,000 mi. Very little data were returned by the tetrahedral satellites. However, an octahedral satellite launched to carry out the same function with the third pair of satellites returned a large amount of useful data.

Participants—Management for the overall program is carried out by Air Force Space Systems Div. The payload and detection logic are provided by the Atomic Energy Commission and were developed by Los Alamos Scientific Lab and Aerospace Corp.

Data telemetered from the satellites are received by the Air Force Satellite Control Facility, where they are recorded on tape for dispatch to Los Alamos for data reduction.

Future development—Officials in the Advanced Research Projects Agency associated with the *NDS* program are estimating that it may be four years before launch of an experimental multipurpose satellite that would include a nuclear detection capability.

ARPA spokesmen say they have the nuclear detection technology better in hand than of the other two functions envisioned. Their experience with the six *NDS* packages now in orbit, plus that which they expect to gain with the final pair to be launched at the end of the year, will tell them how to build the detectors they will need aboard the multipurpose satellite.

The *NDS* sensors now in orbit have been described as extremely satisfactory, but the Sun is just now entering a period of considerable activity. A significant increase in solar storms could lead to sensor problems not yet encountered, DOD sources say.

ARPA officials think the multipurpose satellite will call for sensors that are less sensitive than the ones now in orbit. With the 50,000-mi. orbit of the *NDS* packages, the sensors have been exposed to less background radiation than they will be in the 22,300-mi. orbit proposed for DOD's multipurpose satellite.

NDS program officials say they are always looking for added capabilities. The ability to detect nuclear detonations within the Earth's atmosphere is one such refinement sought, even though the present *NDS* sensors can detect atmospheric blasts that occur at high altitude.

Officials do not foresee any major problems in integrating the nuclear detection payload into a multipurpose satellite. Location above the Earth and attitude are their chief concerns, so that the sensors get an optimum "look" at space.

COMMUNICATIONS

Two distinct military communication satellite systems are now expected to come into being over the next few years: the long-range, point-to-point telecommunications system, starting with the Initial Defense Communications Satellite Program (IDCSP) and ultimately growing into the advanced program (ADCSP); and a tactical satcom system for use over relatively short ground ranges by ships, aircraft, and land forces.

First launch of the IDCSP vehicles will be in June aboard a *Titan III-C*. No decision has yet been made on the approach or configuration of the ADCSP, but a system concept is expected to be finalized by about July. RFQ's to industry involving program definition for the tactical comsat vehicle are expected within the next few weeks. No date has been set for conceptual design of the overall system.

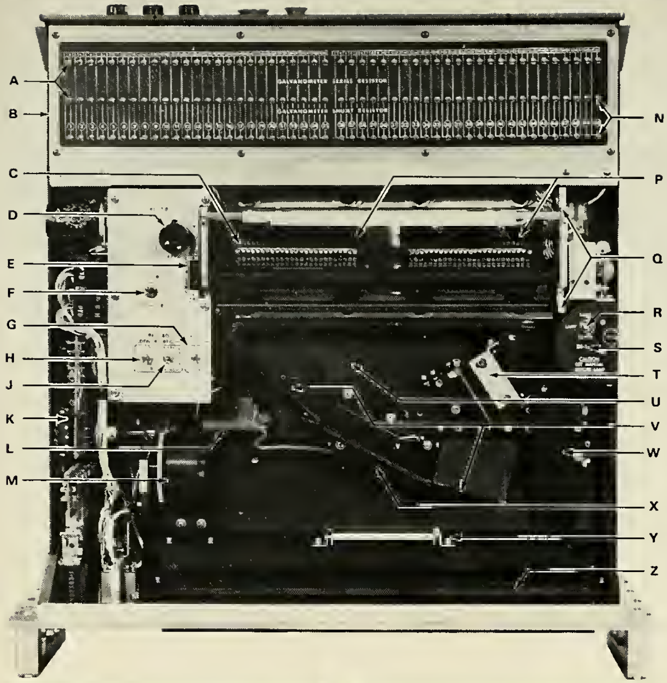
(For a complete description of the military communications satellite program, refer also to M/R Special Report on Space Communications—Jan. 31, 1966.)

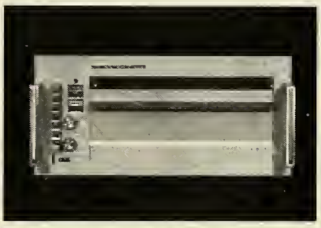
Initial system (IDCSP)—The initial comsat system, although planned for use eventually on an operational basis, is largely considered a global experimental or R&D effort. Based totally on 1962 state-of-the-art design, and a lean one at that, it neverthleless is expected to prove the ability to provide long-haul telecommunications via active satellite for the Defense Communications System.

As presently conceived, the initial system will employ 24 vehicles, launched 8 at a time, in a near-synchronous (18,200 n. mi.) equatorial orbit.

The 100-lb. spacecraft are being built by Philco Corp. Spin-stabilized, the small vehicles will operate in the X-band with a repeater power output to the antenna of 2.5 to 3 watts. A circularly polarized, bi-conical array will be used so that the 25-degree beamwidth will continuously illuminate the Earth segment below.

The June launch vehicle will carry seven IDCSP vehicles plus a *Gravity Gradient Test Satellite* to prove the concept for spacial stabilization at high





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altitude. If the first *GGTS* performs its task well, two more test vehicles may be used in subsequent flights.

Other experimental packages also will be multi-launched throughout the program:

—*DODGE,* a DOD gravity experiment craft, developed by Applied Physics Lab, employs more sophisticated techniques and hardware than the *GGTS.*

—*DATS,* a de-spun antenna test satellite developed by Philco, will be used to test a Sylvania high-gain despun antenna. This concept is considered competitive with the gravity gradient approach to stabilization. While not quite as desirable, it offers the greater potential for success.

A second IDCSP launch is planned for late August. The third launch date has not yet been determined.

The fourth launch package (which could actually be carried in the third *Titan III-C* used in the program and due for launch in December) will carry one *DATS,* one *DODGE,* a Lincoln Lab experimental satellite *(LES-5)* and three or five IDCSP craft, depending on whether two *Nuclear Detection Satellites* are included.

If all launches are successful, the initial system should be ready for operational use early next year.

Advanced system (ADCSP)—The system concept for the Advanced Defense Communications Satellite Program should be finalized about midsummer, say DDR&E officials. A 1969-70 initial launch date is still envisioned, but that date is dependent on the IDCSP system becoming operational as scheduled early next year.

While DDR&E sources admit that the ADCSP satellite could evolve into a multipurpose satellite, they stress that its primary function will be military communications. Meteorology and navigation functions, they assert, are the ones most often lumped with communications in multipurpose satellite discussions. But one DCA official told MISSILES AND ROCKETS, "Our system definition involves communications satellites. Incorporation of other functional devices would be only a secondary consideration at this point."

The Defense Communications Agency has the task of synthesizing the ADCSP concept. DCA officials have met with representatives of the military services so that all three can agree on a program.

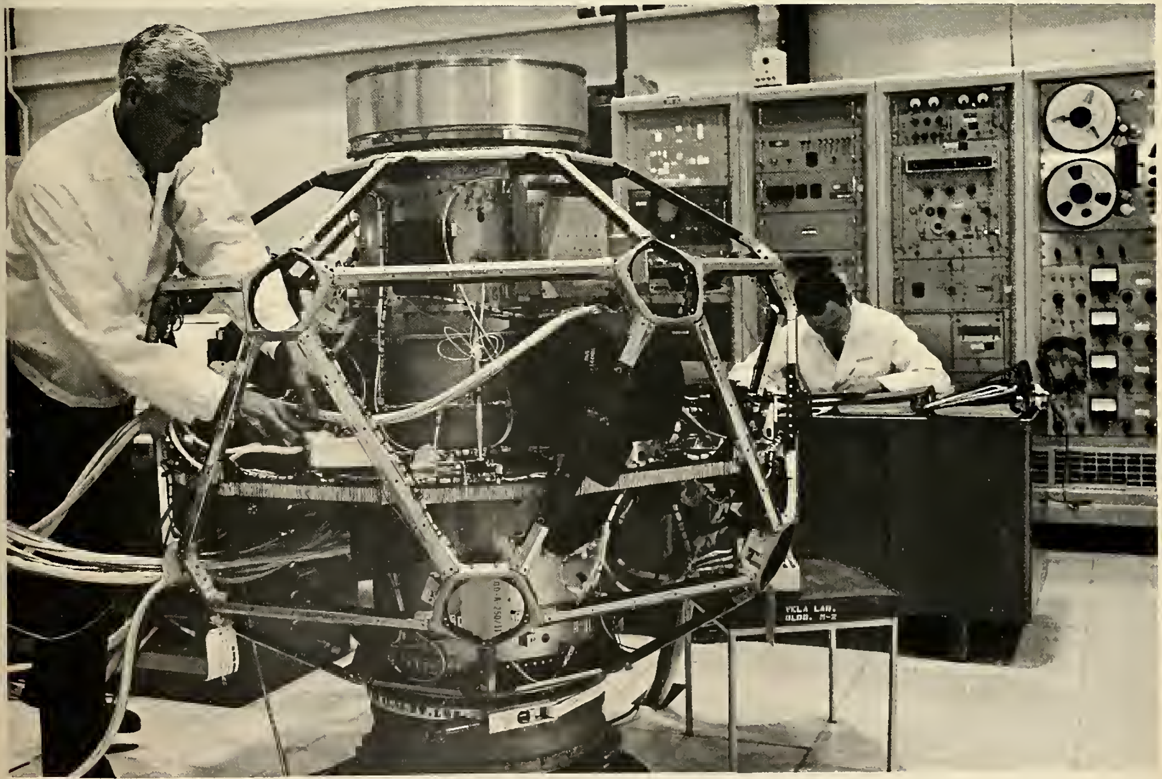
An ADCSP select committee is now reviewing the recommended program. The complete study should go to the Joint Chiefs of Staff by June 15. From there it goes to DDR&E, with a recommended course of action, for a decision by Aug. 1. If the program go-ahead is given, a request for proposals for the system's contract definition phase, if one is needed, could come out this fall.

It should be pointed out, however, that despite the committee approach to determination of and recommendation for an "ADCSP," there is widespread belief in the Air Force that such a system will evolve over a period of years without a sharp line of separation between two system concepts. Rather, they assert, advanced hardware will be integrated with the IDCSP until it reaches the point where none of the original spacecraft remain operational. At that point an ADCSP will be operational.

The important point, they say, is that once operational, the military communications satellite system must provide an uninterrupted service capability.

Each of the ADCSP satellites is expected to have about 30 times the capability of the IDCSP satellites, and will have a secure command system and as much anti-jamming as possible. It will be a synchronous or near-synchronous station-kept system, probably with eight satellites to provide adequate backup, and will be compatible with present ground stations.

Nuclear Detection Satellite (formerly Vela) undergoes lab testing during final assembly as TRW Systems.



Each satellite will have an Earth-coverage antenna. It is still very much an open question as to whether mechanical or electrically de-spun antennas will be used.

Multiple-access problems are still the biggest headache in military communications satellites, because of the requirement to handle all possible combinations of ground terminals. The problem is alleviated to some extent by the added requirement for secure communications. The use of crypto-secure codes with key stream generation to meet this requirement automatically produces a system with multiple access.

Costs for the system are not yet firm, although estimates were provided in each of the six system studies done by industry (Philco, GE, Hughes, Comsat Corp., TRW and RCA).

DDR&E sources say the ADCSP will likely be proposed as a satellite project handled in the same manner as the IDCSP, with the Air Force responsible for space systems procurement, the Army for ground terminals and the Navy for shipboard terminals.

Terminal points have been established in detail, according to DDR&E officials. Specific modes and the number of expected users are classified, however, since they reflect detailed requirements established as the basis of need for the ADCSP.

Tactical SatCom near—DDR&E officials hope to see award of a hardware (not system) contract early this fall leading toward an operational tactical communications satellite network by 1971-72. Despite the attack on hardware needs first, the contract will be of the program-definition type.

Requests for proposals for an advanced development satellite for tactical use are to go to a broad segment of industry in the next few weeks. The satellite is to weigh 1,500-1,800 lbs., will have both VHF (230 mc) and UHF (7-8 gc) capabilities, and probably will be designed for placement in a near-synchronous equatorial orbit in the second half of FY '68, according to one official.

This same source described the effort as a "multimillion-dollar program in the next 2-3 years." Three such satellites could be employed to cover the Earth. The official hastened to add that this first satellite in the evolution of a tactical comsat system will be strictly experimental. "If it lives a year, we'll be satisfied with it," he said, pointing out that there are many technical problems to be solved before such a system will be accepted. The major problem with such a system will be in providing a satisfactory ground interface.

Systems problems include determining the optimum frequencies to be used, the need for signal processing because thousands of users will be transmitting short bits of data, the need for an anti-jamming capability and the need to eliminate down-link noise at UHF.

But, M/R's informant pointed out, industry has been working in-house for more than a year on the kind of capabilities sought in this initial experimental tactical comsat, and is ready to respond with solutions.

DDR&E officials then hope to move from advanced development in FY '68 to an RFP for system concepts for an operational system, and ultimately to an operational network.

The advanced development satellite, say DDR&E officials, will not attempt to fulfill any other function than short range (ground-to-ground) communications. It will not be a multipurpose satellite, mainly because it has to be too sophisticated just to meet the tactical communications requirement.

Complexity will be concentrated in the satellite, rather than in ground terminals, so that a variety of field users may acquire and use it with the least equipment possible on the ground. This equipment, ideally, might be as simple as a whip antenna carried by an infantryman.

One non-technical obstacle also might have to be overcome before military commanders will be "converted" to tactical communications via satellite. The services now have a vast investment in conventional communications equipment; industry will thus be challenged to prove the reliability of any tactical comsat system it develops.

But DDR&E sources feel that once this reliability has been shown, military commanders will not only accept but will press for satellite communications because they will be able to function without the considerable amount of redundant ground equipment they now need for effective tactical communications.

NAVIGATION/GEODESY

Navy Navigational Satellite System (NNSS) proponents urge that it also be employed in a geodetic vehicle role. *SECOR* enthusiasts urge that the Army's geodetic vehicle could provide a lower-cost and equally accurate navigational system.

DOD officials say that no real argument exists and no major change in either system is even being considered because DOD is happy with both systems operating as designed. And that, they say, is that.

This does not mean that either system will not experience system improvement over the next few years. Dan Fink, DDR&E deputy director, has said that NNSS has and is providing "precise positioning information for the Fleet Ballistic Submarine Force, several attack aircraft carriers and other select surface ships that require precision information not achieveable by celestial or by Earth-based radio devices."

He also has stated that with NNSS experience and geodetic and magnetic fields, data obtained by *SECOR* and other satellites (which has significantly increased our knowledge of the Earth's shape, magnetic fields, and relative distances between major land points), the time is close for publishing a "satellite ephemeral almanac."

Such a document, he said, would accomplish two basic objectives: 1) permit use of a simpler navigational satellite system by reducing the present need for a large ephemeral memory subsystem; 2) reduce ground and shipboard equipment complexity.

If such simplifications can be achieved, there appears to be no reason for not using satellite navigation in tactical warfare situations by all participants—land, sea and air forces. This would solve the age-old problem of trying to establish unit position on relative coordinates.

Satellite position fixing, said Fink, can provide a common coordinate tie among all units with a common set of relative coordinates.

This also would permit, for the first time, serious consideration of long-range tactical bombardment missiles for close support of troops in the field.

NATIONAL RANGE RELAY

A data-relay satellite system to support the national missile/space ranges is being considered as a joint NASA/DOD venture (M/R May 16, p. 12).

Through its Electronic Systems Div., the Air Force has performed preliminary feasibility studies and the outlook is optimistic, according to Dr. John S. Foster, DDR&E director. Two studies were performed by ESD and the results of each were submitted for review by NASA officials some six months ago.

In the meantime, NASA has selected RCA and Lockheed to perform a feasibility study for an Orbiting Data Relay Network. Both NASA and DOD are looking toward development of such a system by the early 1970's.

Although ESD officials deny any knowledge of such a specific application, DOD officials have indicated to M/R that support for manned programs—and particularly the *Manned Orbiting Laboratory*—is the primary requirement for the new relay net.

ESD study—The satellite evolving out of the ESD study is called *"C-Cubed,"* for *Command, Control* and *Communications Satellite*. Work on the system began about a year ago as a

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study to define a high-orbit—probably synchronous—satellite that could track, and record the position of other Earth-orbiting bodies.

Studies showed, however, that such a satellite would be beyond both the present and near-future state of the art. Therefore, the tracking mission was dropped in favor of emphasis on a similar system that would operate primarly in a global data-relay network.

In this mode of operation, the *CCC* satellite would be configured to interrogate any given orbiting body containing proper communicating equipment and gather real-time or stored data from that body. It then would either store the information for later re-transmission to a selected range station or transmit it immediately to a selected station.

Justification for such a satellite net, ESD said, is that too often orbiting bodies are totally out of communication range with ground, aircraft, or ship-based range facilities, and thus radio blackout periods are experienced during flight.

With the *C-Cubed* satellite, however, no such blackouts would occur, and real-time or delayed communications could be constantly maintained with any range facility desired. Also, with the *C-Cubed* satellites, no extension to present-day ground links would be required.

The new satellite, it is envisioned, could also be used to control orbiting bodies, causing them to operate upon command, make orientation maneuvers, or possibly change orbits.

What next?—Current status of the program is still in a low-level-of-effort analysis phase. Present emphasis is on investigating requirements of all military services for such a system.

ESD, with Mitre help, is also coordinating its findings with NASA to determine NASA's requirements in this area, since they differ somewhat from military needs.

ESD officials were unwilling to predict future direction or level of effort for the program, primarily because NASA is now drawing up design requirements for a satellite of this type—including the tracking operation mode—to satisfy its needs.

Thus, it may be that ESD will not carry the present study much further than requirements definition. A decision must follow eventually as to which organization will proceed with program responsibility.

RESEARCH

Through use of secondary payloads (piggyback) and multiple-satellite launches, the Air Force Office of Aerospace Research, working in conjunction with Space Systems Div., will carry out some 30 experiments with up to 15 satellites during FY '67.

A total of 11 satellites carrying 22 experiments were planned in FY '66 in the Aerospace Research Satellite Program. Through this effort, scientific and engineering experiments for all the service laboratories and NASA are selected as a low-cost means for carrying instruments into space.

The total OAR budget of $10 million a year for the program is expected to remain constant over the next several years, according to DOD officials.

In-house competition—Because the prime payloads on many Air Force launches do not make use of the full capability of the launch vehicle, piggyback satellites are often carried. SSD has set up a Space Experiment Support Office to coordinate the use of secondary payload space on boosters. The division considers that with responsibility for Air Force space programs, it is in the best posititon to allocate secondary rides.

The Office of Aerospace Research, however, already has a mechanism for allocating secondary payload space for scientific experiments (M/R, Jan. 17, p. 32).

Since secondary payloads may not necessarily be scientific (some have an engineering support function), there is the question of how overall priorities are to be decided and by whom.

In some cases, the accommodation of a secondary payload has been arranged on a project-to-project basis within SSD. The piggyback ride for the sattelite portion of the Space Ground Link Subsystem, for example, was arranged before the Space Experiment Support Office came into being.

Orbiting vehicles—OAR's orbiting vehicle series *(OV1, OV2, OV3, OV4,* and *OV5)* are used in the Aerospace Research Satellite Program to provide Air Force and other service laboratories with a low-cost means of carrying scientific experiments into space.

ARSP was originally conceived as using piggyback launches, but with rescheduling of the prime payloads, it turned to use of surplus boosters. By flying as many as three satellites on one *Atlas* launched from Vandenberg, OAR expects to keep the cost of the scientific payload low.

OV1 satellites produced by General Dynamics/Convair are chiefly flown aboard *Atlas* boosters, either from side pods or from a special dual pod in the nose. Because of the unfortunate location of the launch site used for these surplus boosters at Vandenberg, the satellites cannot be put into polar orbit but have to be launched westward into retrograde orbits.

OV2 satellites make use of *ARENTS* structures modified by Northrop Space Laboratories for use on *Titan III-C* launches.

OV2-2 and *OV2-1* both failed to go into orbit because of *Titan* Transtage malfunctions. Next in the series, *OV2-5* may fly next spring.

OV3 satellites are general-purpose vehicles designed to be launched singly on six *Scout* vehicles owned by OAR. Vehicles *OV3-1* through *OV3-4* are being built by Space General Corp. *OV3-5* and *OV3-6* are being built in-house by Cambridge Research Labs. *OV3-1* was successfully launched in April and is in polar orbit, returning data on the Earth's radiation environment.

OV4 consists of two satellites, a transmitter and a receiver, being built by Raytheon for the Avionics Laboratory at Wright-Patterson AFB. They are scheduled to be flown on the *MOL/Gemini* heat shield qualification test this fall.

OV5 is the Octahedral Research Satellite series built by TRW Systems Group. These generally will carry one experiment. The first is expected to carry a zero-g heat transfer experiment for the Rocket Propulsion Laboratory, Edwards AFB. The second is to carry a vacuum friction experiment for the same lab.

AGENA

The standard Air Force *Agena* upper stage vehicle can carry a wide variety of optional equipment for in-orbit experiments. There are 48 pieces of optional hardware that can be fitted to the vehicle, which is made by Lockheed Missiles & Space Co. Optional electronic gear is usually attached to the forward end of the vehicle, and optional propulsion gear to the aft end.

Agena normally flies in a roll-stabilized mode with its nose pointing in the direction of flight. A strapped-down inertial reference package gives a local vertical reference, while roll stabilization is achieved with infrared horizon sensors (M/R, Oct. 25, p. 26).

Less than 10 *Agenas* are believed to have been used for in-orbit experiments, including the *Gemini* target vehicle. Developers of classified Air Force space payloads generally find it more convenient to equip the payloads with their own attitude-control system. Unofficial tracking has indicated, however, that a surveillance capsule has been stabilized by leaving it attached to the *Agena*. The capsule was subsequently returned to Earth and the *Agena* spacecraft lost its stabilization. ■

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Pioneer in the design and development of command and control systems, MITRE was formed in 1958 to provide technical support to agencies of the United States Government. MITRE's major responsibilities include serving as technical advisor and systems engineer for the Electronic Systems Division of the Air Force Systems Command and providing technical assistance to the Federal Aviation Agency and the Department of Defense.

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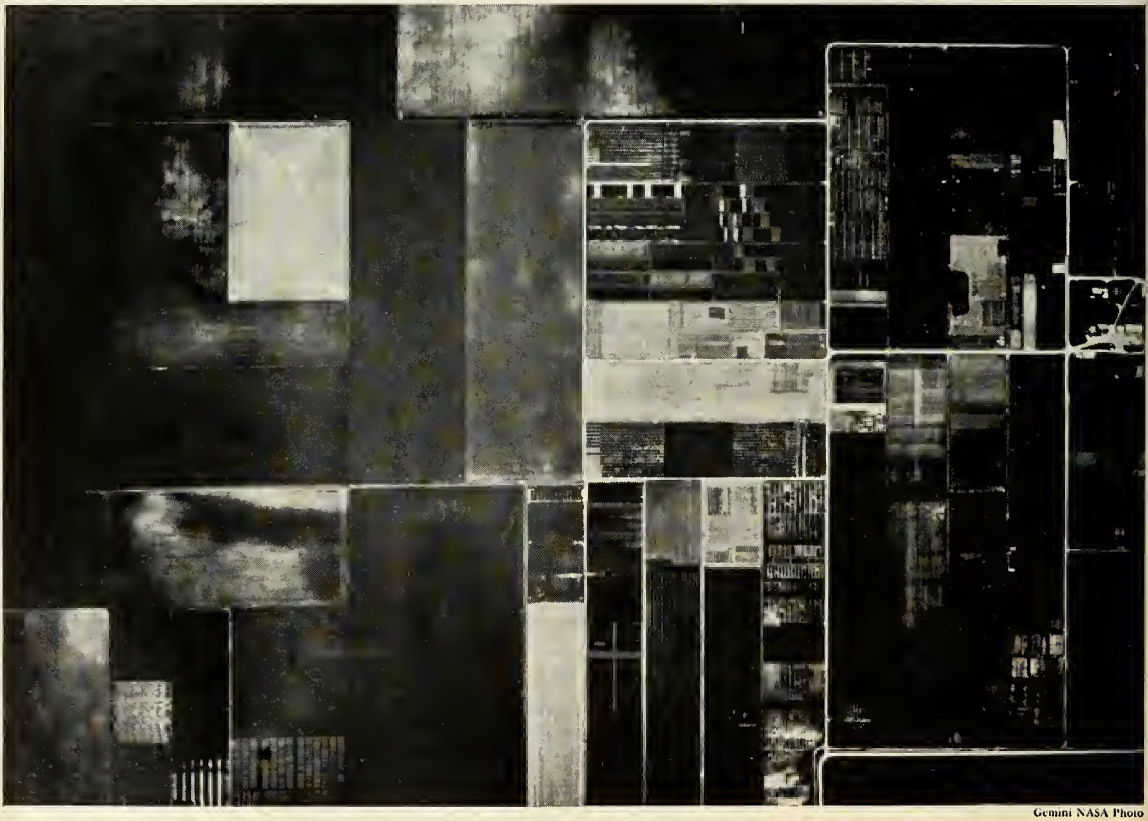
Tackling jobs like these takes systems know-how

☐ Solve down-to-earth problems from space
☐ Set a new standard of reliability for Saturn computers
☐ Help Gemini keep a date with Agena



Gemini NASA Photo

Solving down-to-earth problems from space. ☐ Orbiting space stations 200 miles high will provide a new point of view for the study of earth resources, weather patterns, oceans, and crop yield. With this information scientists will be able to recommend action to avert famine, flood, and disease. ☐ IBM's job: define space station experiments for NASA. The completed study identifies experiments which have significant "payoff"; details and groups them into spacecraft configurations. The result: Orbiting Research Laboratories planned to provide mankind with new information about Earth. ☐ ORL experiments will show him how to better utilize earth's resources, forecast weather activity, and plan for a growing world population.

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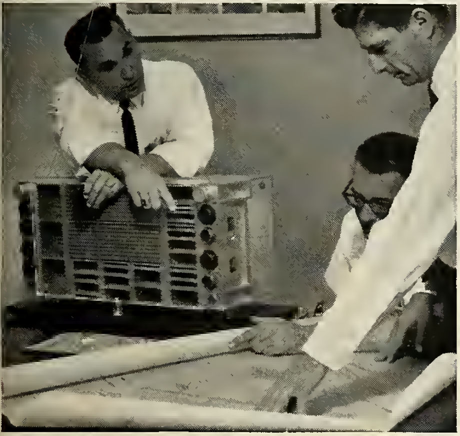

Setting a new standard of reliability for Saturn computers. ☐ For the on-board computer to command Saturn launch vehicles, IBM employed a new computer self-checking technique... Triple Modular Redundancy. ☐ It works like this: vital circuits in the system are triplicated. A "majority voting" circuit monitors all three modules and blocks out any signal not agreeing with the other two. Some 100 voters check an average of 14 output signals from each module. ☐ TMR protects the Saturn mission against intermittent error. As a result, the computer has better than 99% probability of perfect operation in every mission.

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NASA Photo

Helping Gemini keep a date with Agena. ☐ With IBM's 59 pound on-board computer. ☐ NASA's ground control now tells Gemini where to go to start rendezvous. Then spacecraft radar locks on the target vehicle and its data is fed to our on-board computer. Making up to 7000 calculations per second, the IBM system produces and displays necessary thrust values and vectors to close with Agena. Then the Gemini astronauts guide their craft to the final docking maneuver. ☐ For rendezvous, IBM's on-board computer performs more than 13 million operations translating celestial mechanics into spacecraft commands at computer speed, making the Gemini/Agena match a success. ☐ Our computer is a veteran of outer space, having flown on all flights in the McDonnell-manufactured Gemini craft since January 19, 1965. In addition to rendezvous, it backs up the booster's guidance during launch—updates information from ground systems for display to astronauts—and helps guide Gemini to a planned splashdown point.

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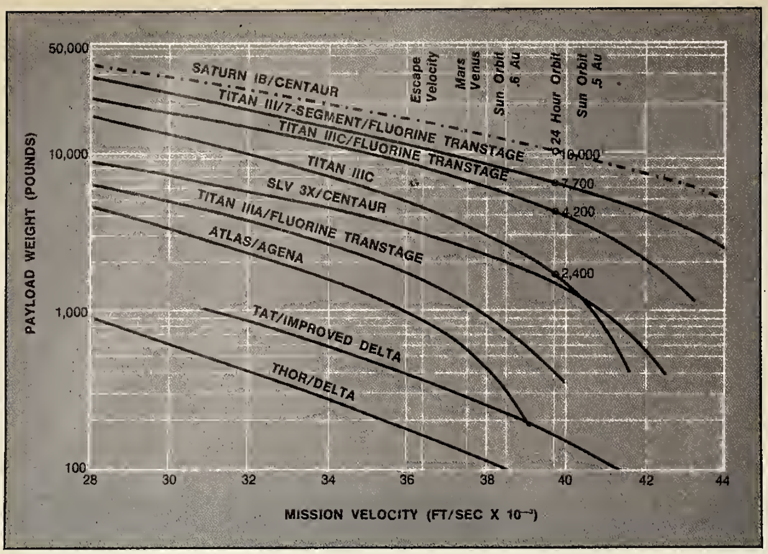


Comparison of possible launch vehicle combinations using available systems and fluorinated Transtage. Scout is not shown. The Air Force is also interested in the Minuteman ICBM first stage as a launch vehicle. There is a good possibility that contracts will be let by the Air Force for investigations of the cost effectiveness of the Minuteman first stage as Minuteman I's are phased out of the weapons inventory. Funding possibilities for such an effort look good, since the alternatives for the weapon's stage 1 are destruction, planned storage or use as a boost vehicle.

Launch Vehicles

Building Blocks Reaching Payoff Stage

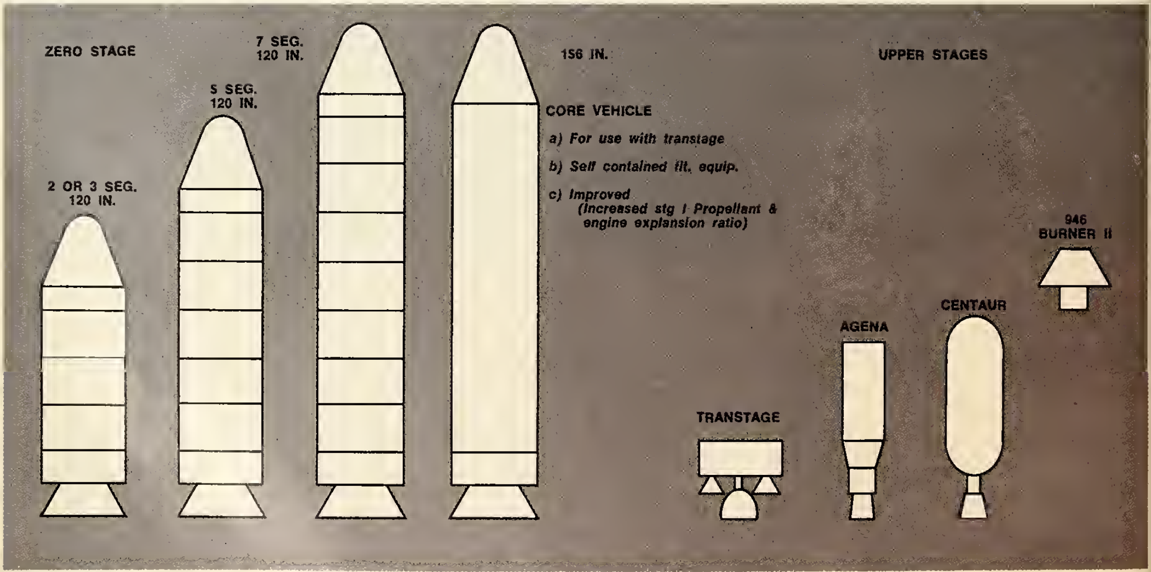
by John F. Judge

WASHINGTON—The military launch vehicle stable is full. Every mission now under serious consideration can be fulfilled by existing and developmental propulsion systems.

Discussions with Department of Defense, Air Force and industry experts indicate that there is general agreement among all on the total lack of a requirement for an all-new launch vehicle system within the next five years—and few signs that such a requirement will emerge in the following five years.

The building-block approach taken by DOD over the past years has resulted in an almost fantastic series of possible upper- and lower-stage combinations, which can respond equally

Combinations within the state of the art in the Titan III family and other upper-stage systems. So-called "big-core" element is not included in the defined core alternates shown. These configurations are valid, but only the Titan III-C combination is currently funded. Other elements are funded as separate items by the military or NASA.


ZERO STAGE
2 OR 3 SEG. 120 IN.
5 SEG. 120 IN.
7 SEG. 120 IN.
156 IN.
CORE VEHICLE
a) For use with transtage
b) Self contained flt. equip.
c) Improved (Increased stg I Propellant & engine explansion ratio)
UPPER STAGES
TRANSTAGE
AGENA
CENTAUR
946 BURNER II

well for near-Earth, equatorial, synchronous and deep-space military missions. The major hitch is that not all of these propulsion systems are operational. The full stable will really come into being only if current programs are pursued with adequate funds.

The military and NASA cooperate at both the working and management levels in booster and launch vehicle requirements and technology.

New cryogenics coming—New propulsion concepts in large cryogenic chemical systems are being funded by the Air Force in the advanced development category with a Fiscal Year 1966 allocation of $8 million and a proposed FY '67 funding level of $6 million.

Known as the High-Performance Cryogenic Rocket Technology Program, the effort involves two firms. Rocketdyne Div. of North American Aviation is investigating a 1,500-psi toroidal combustion chamber together with a chamber tap-off turbine drive and an altitude-compensating aerospike-type nozzle.

Pratt & Whitney Div. of United Aircraft is researching a 3,000-psi transpiration-cooled combustion chamber, together with a topping cycle turbine drive combined with high-expansion-ratio bell-type nozzles.

The propellants in both cases are hydrogen and oxygen. Air Force intent is to develop the technology necessary for the engineering development of flight-weight engines in the 100,000- to 500,000-lb.-thrust class.

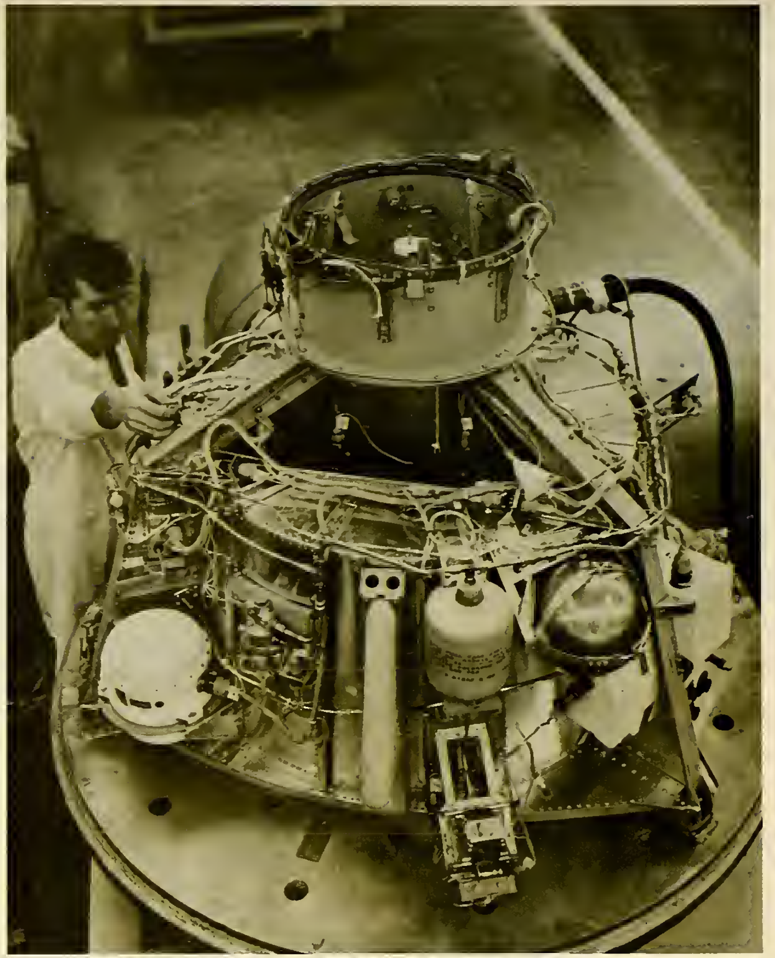
The engine modules ultimately developed will be used either as single, high-energy upper-stage powerplants or in a variety of multiple-engine clusters to propel reusable launch vehicles.

Just how far in the future this ultimate use will be can be understood by the reference to reusable launch vehicles. Most experts consider these to be essentially out of sight.

Flight-weight nuclear reactor systems—now being developed by NASA for its own propulsion missions—are not seen as likely candidates for military space missions, at least not those missions now on the planning boards.

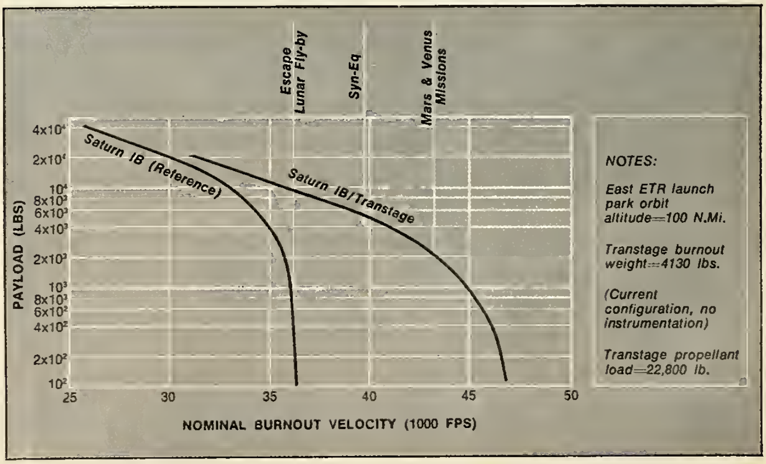
The *Thor/Ablestar*, *Thor/Agena D*, thrust-augmented *Thor*, and the *Atlas/Agena D* are all proven vehicles and handle almost all current military space launches. Most of these vehicles have a healthy future. *Scout* is a NASA-developed booster used by the Air Force for specific missions.

The building-block approach essentially involves the next generation of vehicles—based on the *Titan* vehicle and covering the large-solid zero stages as well as a combination of upper stages.



Boeing's Burner II upper stage (Program 946), which is being considered by the Air Force for use in combinations of current propulsion systems proposed for deep-space missions. Burner II might also be used in launches into low-Earth orbit. Burner II has not yet been launch-tested.

Possible applications of the Transtage unit in combination with NASA's Saturn IB based on a Martin Co. performance projection.



NOTES:

East ETR launch park orbit altitude=100 N.Mi.

Transtage burnout weight=4130 lbs.

(Current configuration, no instrumentation)

Transtage propellant load=22,800 lb.

The Titans—*The Titan III-C*, a *Titan II* storable liquid core slung between two five-segment, 120-in., 1-million-lb.-thrust solids, topped by a *Titan II* second stage and then the versatile Transtage, is now in flight testing. It is the first in the family since the *Titan III-A* (*Titan III-C* core without solid zero stage) which, although flown, is considered a building block rather than a launch vehicle in its own right.

Transtage troubles in past launches have been analyzed and Air Force experts are convinced there are no design difficulties. Thus, the next *Titan III-C* launch has been delayed for about three months while an intensive checkout procedure is pursued.

The next two *Titan III*-type vehicles about to enter active development are the seven-segment 120-in.-dia. solid configuration chosen as the *Manned Orbiting Laboratory* launch vehicle, and a two- or three-segment 120-in.-solid zero-stage version for intermediate payloads. There is little doubt about its becoming operational.

The *Titan* core used in these vehicles is essentially the same as the *Titan II*. An improvement program is now being initiated, however, to increase the nozzle expansion ratio for altitude starts, improve the injector design, and increase propellant capacity. These changes will be in the first stage and will result in significant performance increases at a relatively negligible cost. The current *Titan III-C* development cost is in the $900-million area and the improvements amount to only a small fraction of this.

Mission analyses performed by the Martin Co., developer of the basic *Titan* vehicle, indicate that many military missions can be performed by using various segmented 120-in.-solid and 156-in.-solid zero stages combined with three core configurations topped by Transtage, *Centaur* or *Agena* propulsion systems. The studies also include using the Boeing *Burner II* (Program 946) as a fourth stage (see charts).

Upper-stage combinations—Martin officials are convinced that the Transtage can be coupled to current fluorine technology resulting in a new high-energy upper stage. The fluorine technology has been under development by Air Force and NASA for several years. Martin experts say it would be well worthwhile to start narrowing this effort to focus on such a vehicle as the Transtage.

Calculated performance levels involving all these combinations are comparatively shown in the accompaning charts.

In early *Titan III* planning, both *Centaur* and *Agena* upper stages were considered. The reasons for not actively pursuing these avenues were largely economic, although it was determined that both upper stages are feasible in combination with the current *Titan III-C* minus the Transtage. However, there

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The Tactical Air Command believed that a modern wiring analyzer used at field level could provide significantly improved weapon system reliability and availability.

Many months of testing in the field proved that TAC's concept was correct. Air Force technicians, working at the field level, programmed, adapted, operated and maintained the wiring analyzer. The net result was a substantial increase in readiness and **operational** reliability.

Official objectives and results of this test program are available now—presented in detail in Air Force Test Order 64-96, for qualified recipients of Air Force documentation.

The Hughes FACT (Flexible Automatic Circuit Tester) was used for providing this new dimension in maintenance test technology. Information is available from: Hughes Aircraft Company, El Segundo Division, Mr. L. W. Risner, FACT, P.O. Box 90426, Los Angeles, California 90009.

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new freedom in designing leakproof connections between dissimilar metals

no brazing or flanges
required at the transition area

tubular transition joints between aluminum, stainless, and titanium save weight and space — are metallurgically bonded, stronger than the weaker member, and absolutely leakproof

The tube at the left is 304 L stainless steel at the top and type 6061-T6 aluminum at the bottom. It would be impossible to make the transition joint any simpler. No flanges. No braze alloys. No anything. It is incorporated into any system simply by welding stainless to stainless and aluminum to aluminum.

Impossible, too, to find a joint more reliable. It is absolutely leakproof. And it remains that way in liquid helium, liquid oxygen, ethylene glycol, or boiling water. It remains that way under repeated thermal cycle or shock. Stress it in any way and the aluminum will fail, not the joint.

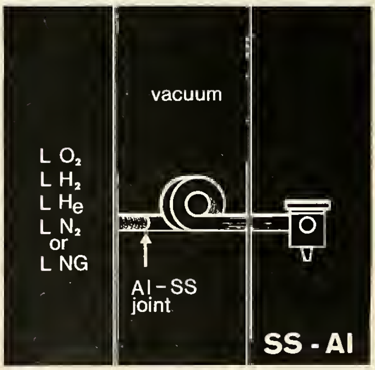
We make no assumptions about it. Before shipment, this joint was thermal shock tested ten times between liquid nitrogen and warm water; proof-pressure tested at 1000 psi; shear tested by torquing to 125 inch-pounds; tension tested by longitudinal stressing to 20,000 psi; dye-penetrant tested by Zyglo with ZI-1C penetrant; and leak tested to 1 x 10^{-9} cc/sec.

These tubular transition joints present important advantages in cryogenics, in lighter aerospace components, in countless other applications where simplicity is essential and reliability cannot be compromised.

Other combinations of dissimilar metals are being made — stainless and titanium, titanium and aluminum, and scores of others. Formed in vacuum under the heat and pressure of coextrusion, they are uniquely suited to withstand the vacuum, heat and pressure of your application.

Write — or better still, call directly. Ask for the Custom Products Department. We can discuss your tubular joining problem with authority. In detail.

Stainless steel to titanium joints are being used in the LEM and Apollo space programs, in the Minuteman, and other rocket and missile activity. They permit more liberal use of lighter weight unalloyed titanium, Ti-6Al-4V and Ti-5Al-2½ Sn for handling liquefied hydrogen, N_2O_4 fuel and other liquids and gasses.



Apart from their use in aerospace, stainless steel to aluminum joints are finding a growing demand in commercial cryogenic applications. Aluminum weighs less, costs less. As shown above, the quick transition to stainless cuts down appreciably on heat losses, and economically simplifies the storing, handling, and shipping of liquefied gasses.

Aluminum to titanium joints have been developed to give Nuclear Metals an integrated capability: the joining of three widely used metals — aluminum, stainless steel, and titanium — in any combination. Whether your new assignment is in oceanographic research, Poseidon, or MOL, the simplicity and reliability of Nuclear Metals leakproof transition joints may be of considerable benefit.

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collage

More Motorola Melange, continued from page 12

The fastest draw in the West

not to mention develop and deliver

Our Western Center CW Transponder Section is currently trying to recover from nervous exhaustion incurred while designing, developing and delivering a 100w, 420 mc Command and Time Mark Transmitter. They did it all in less than 30 days, which must be some kind of a record. The device is being used with one of our command receivers by the Astro Geology Branch of the U. S. Geological Survey in Flagstaff, Arizona. It has something to do with lunar surface seismic experiments to be performed by Apollo astronauts.

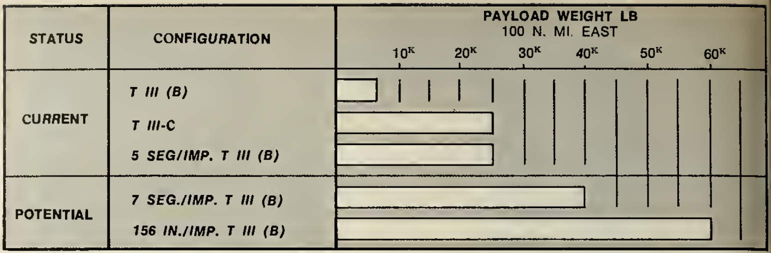
IN QUEST OF THE XB-70 WITH GUN, CAMERA & MICROWAVE

We have a fascinating story about how our Chicago Center guys installed a data acquisition and telemetry microwave relaying system along the high-speed test range that runs from Wendover Field in Utah to Edwards AFB, and thence to Vandenberg. In use since the first XB-70 flight, the system comes in for careful scrutiny in our next Engineering Bulletin. Write for your copy.

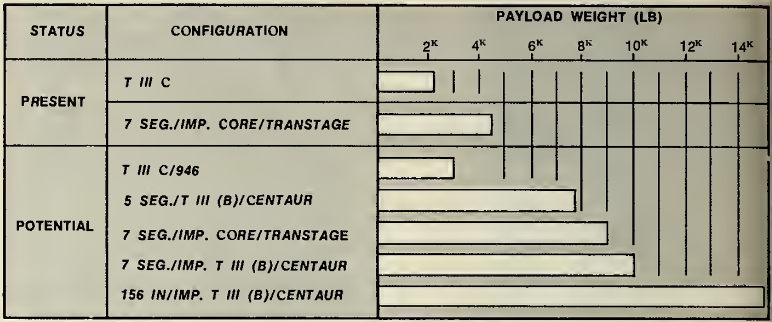
Hey Lockheed!

One of our suppliers recently missed delivery by claiming, "We sent the parts to Lockheed." If any Lockheed people who read this have some strange parts sitting around, send them to our Western Center's Receiving Department. Thank you.

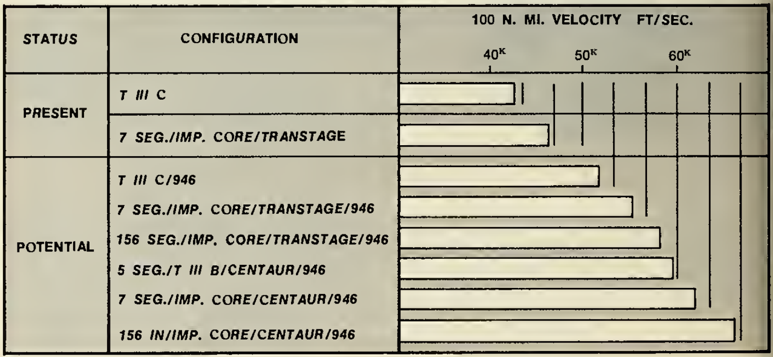
Continued on page 89



Low-Earth-orbit launch vehicle building-block combinations as pictured by Martin Co. planners. The Boeing Burner II stage could be added, as well as a Transtage, as propulsive elements.



Configurations within the building block possibilities designed to handle synchronous equatorial-orbit missions. The number 946 is that assigned to the Boeing Burner II.



Deep-space missions within the reach of possible building-block combinations. Again, the 946 refers to the Burner II stage. All figures and combinations are Martin Co. projections based on performance values developed within the propulsion systems that exist today. The Transtage fluorine uprating is not part of this deep-space projection.

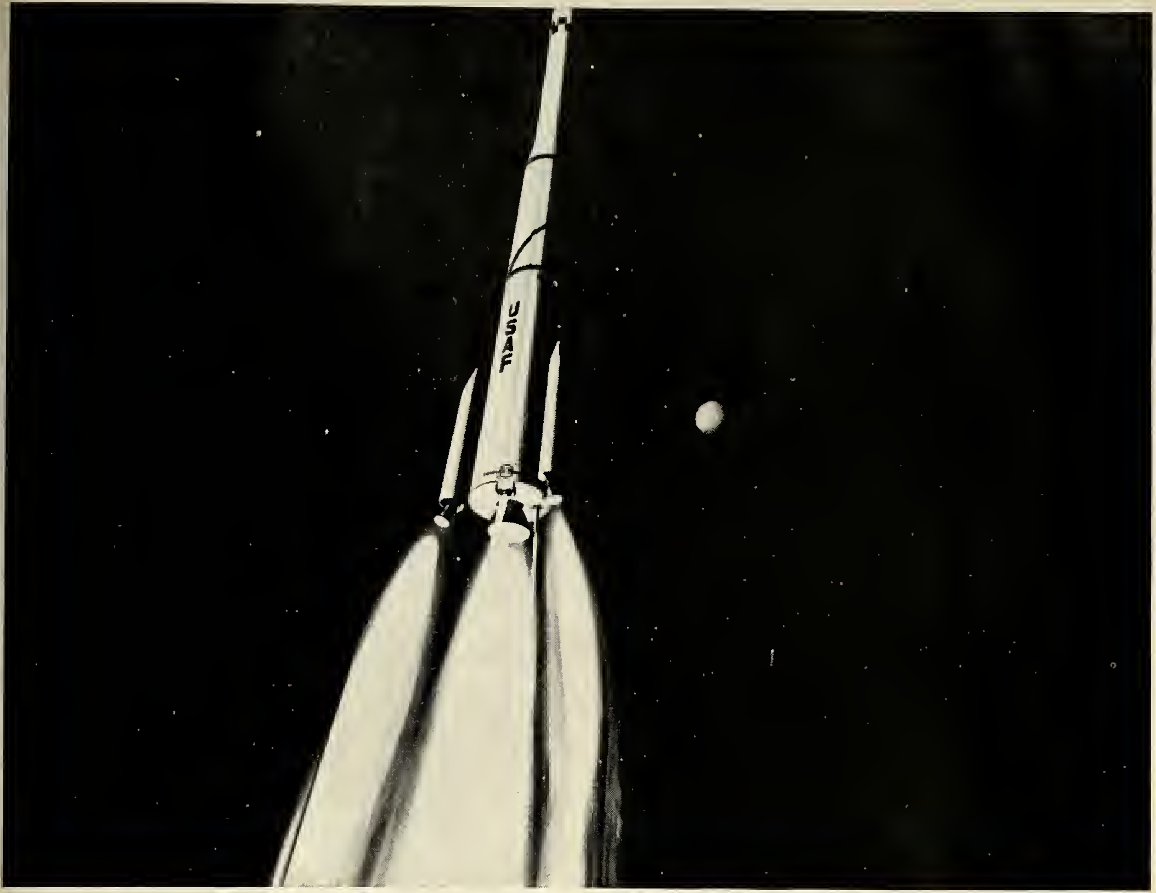
are no definite programs involving any of these combinations other than the current *Titan III-C*—the lower-segmented version, and the seven-segment configurations.

But *Centaur* is being developed and is flying. *Agena* is a proven upper stage and *Burner II* is being designed and built by Boeing. Lockheed is now approaching the Air Force with plans to uprate the *Agena* and move it into the *Titan* building-block series.

The 156-in. solid rocket is now a technology program—subsisting on a DOD-imposed funding level of some $2 million per year. At least this is the level planned for the next fiscal year.

There are no stated missions for the 156-in. system as a strap-on. The current funding level is deemed too low even for a technology program by everybody except DOD. In spite of its apparent lack of mission, the big solid still has a strong potential for the *Titan III* program and this application is most likely to be the one that moves it out of the doldrums.

The constant harping on missions as justification for the development of any of the launch vehicle combinations cited often obscures the cost factor—and this is a real factor. Air Force and industry are fully aware of this and every concept is now being approached more on a cost basis rather than any assumption of possible missions. ■



New Air Force/Douglas Long Tank Thor:
14 feet longer–20% increase in performance.

This latest version of the dependable Thor launch vehicle booster has been enlarged from 56 to 70 feet in length. The additional propellant volume in the new long tank will increase burn time from 146 to 220 seconds, making it possible to boost a 20 per cent heavier payload than previous Thor launch vehicle boosters.

The new Long Tank Thor, like the Thrust Augmented Thor that precedes it, once again demonstrates the continuing ability of this highly reliable workhorse booster to meet the ever-increasing needs of the space age. In the past eight years, the Douglas Thor has performed with a reliability record of more than 95 per cent success in 207 space firings.

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Why take your testing to Huntsville, Alabama?

By FRANK S. WYLE, President, Wyle Laboratories

Why Huntsville? Because it is home to one of the most highly concentrated independent centers of scientific testing in the United States, and by far the most comprehensive in the East. In four years, the number of employees at Wyle-Huntsville has grown from 2 to 250, equipment investment has reached $3 million, and volume of testing $6 million per year.

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When you try Wyle-Huntsville for one test, chances are you'll become a regular customer. It's been happening with companies north to south, east to west.

Is Huntsville too far away? Not any more. This old earth has shrunk considerably of late. Phineas Fogg earned quite a reputation by going around it in 80 days; but in 1966, no matter where you are located, Huntsville is right next door. Only 4 hours from Boston and Los Angeles, 3 hours from Houston, 2¾ hours from New York, 2½ hours from Detroit and Chicago. And we'll meet you and/or your shipment at the airport.

We have quite some capabilities at Huntsville. You probably know about the new High-Force Facility, where substructures of Saturn are being vibration tested by ganged Hydrashakers generating 400,000 force-pounds, and the 100,000 cubic foot reverberation room where sections of space vehicles are immersed in 80,000 watts of sound energy to simulate launch noise and aerodynamic buffeting.

But did you know that for all kinds of smaller test specimens we have a whole family of Hydrashakers ranging upward from 10,000 force-pounds—another big family of electrodynamic shakers in the 350 to 30,000 force-pounds range; and a high intensity acoustic facility where specimens such as structural elements and instrument packages can be vibration tested in both reverberation and progressive wave modes?

Did you know that shock-testing facilities permit simulation of shock parameters such as are encountered in transportation, launch, impact, and other modes, including square, sawtooth, half sine, and triangle wave shapes?...and that centrifuges up to 24 feet in diameter, equipped with electrical slip rings and pneumatic/hydraulic swivel joints, afford combined acceleration and functional testing?

Whatever you manufacture, these facilities can tell you what vibration, shock, or acceleration does to it. PRECISELY.

Did you know, further, that a 50-man Research Staff, studded with Ph.D.'s, is available, not only for pure exploration beyond State-of-the-Art in many scientific disciplines, but also to provide practical assistance in solving unusual testing problems?

You may know that a high speed CDC 3200 digital computer is available to process the torrents of data generated by complex dynamics tests; but did you know that you can send in your own AM/FM analog tapes for on-line translation and in-depth analysis by this same digital computer?

Did you know that various rocket propulsion test facilities are available, including equipment for high-flow cryogenic set-ups, high-pressure pneumatic capabilities, high-flow/high-pressure hydraulic loops, and remote hazardous-test sites for programs involving live ordnance and solid propellant items ranging from squibs to large rocket motors?

Did you know that test programs can be set up to cover micro-electronics and solid state components and systems?...and that these programs can test, to the limits of scientific measurement, anything from resistors and "black boxes" to advanced radar, computing and telemetry systems?...that electronic circuit elements involving inductance, capacitance and resistance can be tested in volume quantities?

Did you know that highly efficient instrument calibration and repair service is available which meets all the measurement standards of the National Bureau of Standards and of NASA? ...that the laboratory also establishes recall systems for calibration control, maintains equipment histories, and provides product inspection and analysis services, training programs for inspection and quality control personnel, and measurement standard research capability to government and industry?

You probably have assumed (and, if so, you're right) that Wyle-Huntsville is fully equipped to simulate the natural environments—temperature, vacuum, humidity, sand-and-dust, salt spray, fungus, sunshine, rain, et cetera. But are you aware of Wyle-Huntsville's extensive Space Age materials testing capabilities—physical, mechanical, and metallurgical? And did you know that Wyle-Huntsville is very big in the business of chemical, hydraulic and ultrasonic cleaning? The facilities and procedures meet the most rigid requirements, and include such services as degreasing, pickling, passivating, black-light inspection, millipore and microscopic analysis, and hermetical nitrogen-barrier packaging. If desirable, a fleet of mobile units can be drawn upon to bring the same high-standard services to your door.

And if the laboratory in Huntsville can't handle your job, it's more than likely that the two other Testing Division facilities in El Segundo and Norco, California can. Remember, we are talking about the largest testing company in the country.

Are we too big for small jobs? Not on your life! If your test requires one man or a hundred, an hour or a month, $2 hundred or $2 million, you will receive the same consideration, service and thoroughness, the same care in reporting; the best.

Are we expensive? We may save you money even before we get your job—by drawing upon our unique fund of expertise to suggest a less expensive approach than you have in mind and, quite possibly, one which better meets your customer's wishes. This happens frequently. On cost-type contracts our tremendous backlog of experience and our unexcelled efficiency probably will save you money in the long run. If you're talking fixed price, we're very hard to beat. Either way, you get the time- and money-saving advantages of multiple equipment for backup, seasoned management, unique computational and DP capabilities, and systematized quality control.

When you have a problem, call us—or drop in to see us. We can help you solve it. Better still, ask for a quote. You'll receive impressive proof of what we can do for you.

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No Major Expansion Seen Necessary for ETR Launches

by Kurt Voss

PATRICK AFB, FLA.—The Eastern Test Range will probably not undergo any major changes in its launch facilities in the foreseeable future.

Col. O. C. Ledford, commander of the 6555th Aerospace Test Wing, which has jurisdiction over Air Force launch activities at ETR, says: "We have the core of the facilities we require here for military space work. The *Titan III* is the vehicle to provide military space developmental capability."

He sees the *Titan III* as "the DC-3 of the military space program," and predicts that all developments in the immediate future will be based on adaptations of the liquid/solid vehicle.

The only major facilities modifications he sees would be those required by use of a seven-segment *Titan III* booster configuration, instead of the five-segment solid strap-ons now used. The switch to the longer booster would require modifications of the launch pad flame bucket, the *Titan* transporter undercarriage, and heavy cranes in the solid-motor assembly building.

Expanded ITL not seen—Though the *Titan III* integrate-transfer-launch complex (ITL) at Cape Kennedy could probably be expanded to handle the seven-segment version of the booster, the Air Force thus far has not identified any missions to be flown from ETR which would require this.

High-ranking Air Force officers also admit that the ITL at the Cape would not be readily expandible to handle the 156-in. solid motor strap-on if a mission develops for that vehicle.

The Air Force is preparing a follow-on production plan for additional five-segment *Titan III-C* vehicles (M/R, April 18, p. 14), in addition to the 10 remaining R&D vehicles. The new vehicles will be used to launch replenishment payloads from ETR for the Initial Defense Communications Satellite Program (IDCSP), for nuclear detection satellites and probably for some new multiple engineering payloads from ETR. In addition, the *Titan III-C* will probably be required for lofting communications satellites associated with both follow-on strategic and tactical comsat systems (M/R, Jan. 31, p. 46).

Launch officers here also foresee no changes in command and control facilities outside of the switch in telemetry and command radio frequencies now going into effect. "We have a capability here now that far exceeds our present work load," they have reported.

New recovery concept—At nearby Orlando AFB, the Air Force's Aerospace Rescue and Recovery Service (ARRS) has come up with a new helicopter/in-flight refueling team concept for water recovery which could go a long way toward taking some of the strain off the Navy's recovery fleet.

The operation is especially appealing as planning for the *Manned Orbiting Laboratory* program gets under way.

With *MOL* crews orbiting for 30-day missions, the requirement to be prepared for sudden mission aborts could tie up a substantial number of Navy ships on an almost permanent basis. This is a real and troublesome problem at this point.

Using the new helicopter/fixed wing refueling aircraft team, ARRS officers point out that recovery squadrons posted at key spots around the world would allow *MOL/Gemini-B* spacecraft to be picked up by crews which were continually on alert but which did not have to be on station.

"For the first time," says Col. Bestow R. Rudolph, deputy chief of plans at ARRS headquarters, "we will have a true rescue capability as of the end of this year, even with no support ships in a given area."

At present, ARRS has 30 four-engine C-130's and 10 Sikorsky HH3E helicopters available for its worldwide rescue work. It has been authorized a total of 54, plus backups, in its stock of C-130's, and a total of 24 of the 140-knot helicopter.

Aircraft-helicopter team—Using the team concept, the C-130's double as rescue aircraft, which carry and drop pararescue teams, and as flying tankers, which carry large loads of fuel for the HH3E helicopters.

The newly developed system of in-flight refueling gives the HH3E's an almost unlimited range, and their speed is enough to shift areas of coverage quickly to follow changing orbits.

Should a landing footprint change, the refuelable capability will allow the helicopters to change position immediately without the need to return to land or a ship, either of which could be hours away.

Even larger helicopters—the Sikorsky HH53A—have been ordered. These craft are large enough to pick up the entire *Apollo* space ship from the water and carry it long distances, with the crew still inside, if necessary.

Col. Rudolph predicts that in the near future these larger helicopters will be the prime recovery vehicles, with the Navy doing the support of a pickup mission—just the opposite of today's recovery modes.

Delivery of the new units will start in August when two CH53A's, cargo helicopters converted to search and rescue equipment, will arrive at Patrick. Rescue capabilities with the new craft will start small and grow as equipment funding becomes available.

The HH53A's will be equipped to use the team concept, with refueling capabilities even when carrying full loads.

Emergency rescue—Another new concept, just publicly demonstrated, also is in ARRS plans for emergency recovery use. The first week in May marked the public testing of the Fulton pickup system, by means of which a downed astronaut can be snatched from water or dry land by a C-130, or similar plane, even if weather keeps helicopters away.

Using the system, the downed flyer dons a special suit-like harness. He inflates a polyethlene balloon with helium gas. This balloon lifts a 500-ft. nylon line into the air, one end tied to the harness and the other held aloft for pickup by the plane.

As the aircraft approaches, its pilot lines up a V-shaped guide on the plane's nose with the line and flies into it. As the line strikes, a small arm in the apex of the V suddenly twists, locking the line securely The cable is pulled back by the airstream against the plane's underside, where it is grabbed at the rear of the fuselage and hooked onto a winch.

G-forces on the man being picked up are said to be less than those experienced in a normal parachute jump and much less than those of previous pickup systems.

The entire pickup kit—harness, balloons, gas supply, and nylon line—is dropped by the pickup plane. ■

Launch/Recovery Facilities

WTR Build-up Under Way For MOL, Titan III-C in '68

by Willard Wilks

VANDENBERG AFB, CALIF.—New Air Force launch facility construction beginning this year at Western Test Range (WTR) presages a major strengthening of the U.S. military space posture two years from now.

By mid-1968, according to present schedules, initial launch capability for *MOL* will exist at WTR, where all manned military flights will occur because of the polar orbit requirement (M/R, April 18, p. 14).

Site preparation is now under way on the newly acquired Sudden Ranch property adjacent to Vandenberg AFB. Actual construction of the $18-million ILC (Initial Launch Capability) installation will begin soon.

Capability expansion—Completion of the ILC will mean new capability and growth potential for other important military programs, while providing for manned *MOL* missions. In addition to the seven-segment *Titan III* configuration for *MOL*, the ILC will accommodate any other version of the *Titan III* family utilizing the 120-in. solid strap-ons.

Polar-orbiting programs will be able to take advantage of the 25,000 to 30,000-lb. spacecraft potential provided by the *Titan III-C* family.

"This means that any of the known and classified programs we have been launching out of WTR will be able to utilize the new generation of big boosters and the spacecraft and payload growth that they permit," an Air Force spokesman reported. These programs include communication, nuclear test detection and reconnaissance satellites.

The ILC will consist of one pad where the vehicle will be built up on the pad. Although the facility's launch tower will accommodate only the 120-in. strap-on *Titan III* models, including the full seven-segment configuration, the Air Force is "hedging its bet in the brick and mortar phase of design and construction to permit expansion to accommodate the 156-in. strap-ons if it decides to upgrade the booster in the future," a spokesman said.

"Long-range planning documents and drawings are also such that the ILC could at some future date be expanded into a complete ITL (integrate-transfer-launch) complex, as at Cape Kennedy, with multiple pads."

At present, Air Force plans call for at least five manned *MOL* launches from WTR.

Atlas-Agena launch pad—No other launch construction is needed in the immediate future at WTR, the Air Force reports. In addition to the beginning on the ILC installation, the one other recent improvement has been conversion of one of the *Atlas-Agena* pads for *Titan III-B* (a *Titan III* core with an *Agena* upper stage). The booster will initially be used with the *Agena-D* but is also designed to handle the Transtage, *Centaur* and possible new vehicles.

No other *Atlas* pad conversions are planned at this time. Spokesmen report that the existing eight *Atlas* pads are sufficient for future *SLV-3* launches. "With the new facilities, *Atlas* will be on the way out for Air Force programs," sources said. *"Titan III-C* will become the new workhorse."

The five *Thor* pads at WTR also are sufficient and no new construction needed for the long-tank *Thor*.

On the subject of *MOL* or other recovery plans or facilities, Air Force is making no official comments. It is almost certain, however, that water recovery will prevail in the foreseeable future.

WTR now has no responsibility for recovery. The organization formerly responsible for WTR space-payload recoveries, the 6594th Aerospace Test Wing, Sunnyvale, Calif., has been deactivated. All tracking stations and other facilities of the wing are now part of the world-wide Air Force Satellite Control Facility, headquartered at Air Force Systems Command Space Systems Div., El Segundo, Calif. ■

Flight Support

Instrumentation Needs Low; Majority Are Tied to MOL

WASHINGTON—Few major additions to the national ranges are forecast by the Dept. of Defense to support the growing military space program. Exceptions include the new *Manned Orbiting Laboratory (MOL)/Titan III-C* launch facility at the Air Force Western Test Range and an instrumented range ship to cover *MOL* insertion and injection.

Written by Senior Editor Charles D. LaFond and Associate Editors Rex Pay, Ron Barnhart and Kurt Voss.

Range instrumentation at both Eastern Test Range (ETR) and Western Test Range (WTR) are considered reasonably adequate and need only modest equipment augmentation. Principal system improvements are expected to come in the addition of telemetry capability and new real-time data-handling systems. The Satellite Control Facility is being expanded to handle the *MOL* mission.

The general trend is toward improving efficiency at the ranges through greater use of multi-purpose, self-checking subsystems and of remote operation of electronic subsystems.

DOD officials estimate that annual expenditures for range improvements will be about $20 million over the next five years.

ELECTRONIC SYSTEMS DIV.

Responsibility for instrumentation systems development and management for all Air Force test ranges rests with the deputy for engineering and technology, Elctronics Systems Div., Air Force Systems Command, Hanscom Field, Mass. This work is carried out by the Directorate of Aerospace Instrumentation (DAI). DAI is assisted in most of its projects by the range systems department of the Mitre Corp.

ESD's major unclassified programs dealing with range instrumentation for

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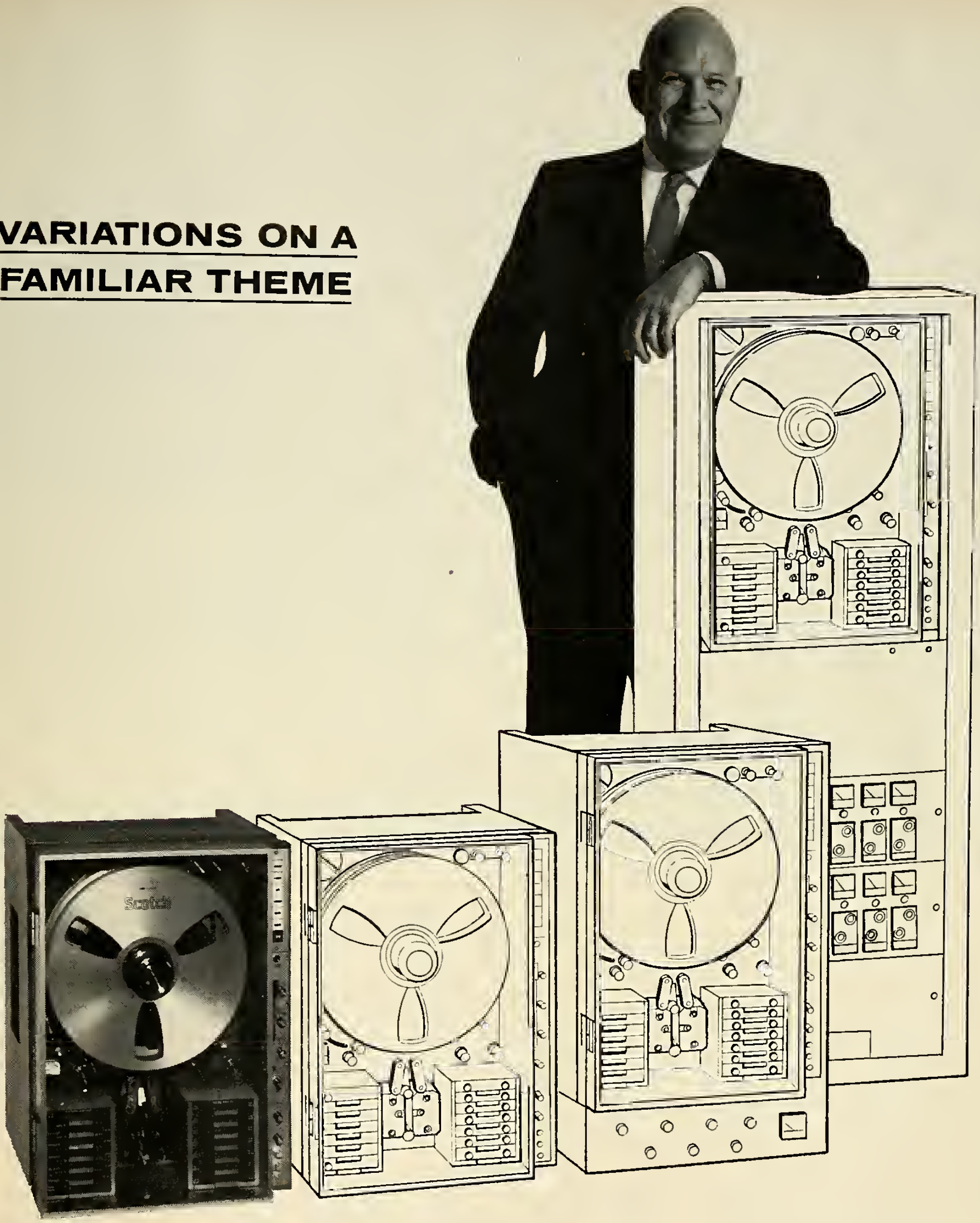

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flight support are as follows:

Range telemetry conversion—DAI coordinates conversion of all national test ranges from VHF to UHF telemetry communications. The frequency bands to be utilized are L-band, for support of all manned missions, and S-band, to support all unmanned missions.

Test ranges to be fully converted to UHF by Jan. 1, 1970, are Edwards AFB, Calif.; Eglin Proving Grounds, Fla.; Holloman AFB, N.M.; Eastern Test Range, Fla.; and Western Test Range, Calif.

ESD's present activities in this area consist largely of requirements analyses, to determine what the space missions of the '70's will be, and, from this, equipment procurements, based on present state-of-the-art telemetry systems, with the drawing up of some component development specifications.

The conversion program began in February, 1965, and to date DOD has invested $40 million to buy, test and install equipment. It is estimated that another $70 million will be required to complete the program.

There are two major reasons for shifting to UHF: 1) there already exists a good deal of interference between the ranges and tactical military units in the VHF band, and 2) the ever-increasing use of wide-band TM systems has necessitated a shift to UHF, where these systems can be more readily accommodated.

Telemetry standardization program—In 1962 ESD, with technical support from Mitre Corp., was assigned the task of standardizing, insofar as possible, the telemetry systems used at all national test ranges. The objectives of this program are twofold: 1) to develop the highest degree of commonality and compatibility in TM systems at all national sites, and 2) to reduce development costs of new equipment.

The TM standardization program is a continuing one which will be in effect as far in the future as ESD can predict.

Telemetry systems development—ESD's budget includes money for advancing the state of the art in the telemetry field. Basic technology investigations in this area are carried out for ESD mainly by the Air Force Avionics Laboratory, Wright-Patterson AFB, Ohio. The Avionics Lab is concentrating on devising new TM-signal modulation and demodulation techniques, designing new TM antenna and test equipment, and evaluating new system components such as thin-film and integrated circuits.

In the area of TM systems development, ESD currently has two major projects under way. The first is the C-130 instrumentation program in support of the Air Force Space Systems Div. This program will enhance aerial-recovery capabilities of the aircraft through development of improved TM receivers, recorders, and data displays.

All C-130 TM equipment is palletized for quick and simple installation and removal. Five such pallets contain all the TM equipment required for one aircraft. Sufficient equipment to outfit 10 C-130's will be delivered to Edwards AFB for operational testing and use this September.

The other major TM program now going on is development of a new digital range safety/command system. This will be used to carry out the destruct functions required during R&D booster launches, and for other command functions.

Two system-definition contracts for the system have been let; both are complete and the final RFP is ready for release. Initially, ESD will buy one prototype system with an option, after prototype testing, for 10-12 more.

The RFP for this system specifies that the equipment contain a good deal of redundant circuitry and have a long mean time between failures, quick-turnaround capability for multiple launch operations, anti-spoof capability, and quick response time. Prototype system is to be delivered 18 months after contract award.

Re-entry systems evaluation radar—The RESER system will be used to evaluate ballistic re-entry systems and study the flight characteristics of multiple re-entry bodies.

The system has been through a contract definition, and a request for proposals to build one system will be issued shortly. ESD's goal is to have a firm under contract for RESER by year's end and have the system installed in the Pacific within 18 months thereafter.

Coherent signal processor—This system is being developed jointly by NASA and ESD. It is in reality a retofit, or modification, to existing range C-band radars—specifically the FPQ-6's and FPS-16's—which, using the Doppler effect, will enable them to make much more precise velocity measurements and double their acquisition range.

A contract for this equipment was awarded in March. The contractor has already delivered a preliminary design, which is now being reviewed by ESD and NASA. The equipment is slated to be operational on radars at Patrick AFB and Wallops Island by next summer.

Radar electronic scan techniques—This is a study project to evaluate the benefits of replacing the paraboloidal dish antennas of shipborne tracking radars with planar phased-array antennas. ESD believes that phased-array antennas will greatly increase the target-acquisition probability of those radars and give them faster track capability.

Two study contracts for devising separate approaches to the problem have been awarded and completed. Both contractors are now developing breadboard models of their proposed equipment, and these will be demonstrated to ESD in June.

Airborne instrumentation platform—Several years ago ESD recommended to Air Force headquarters that tracking systems be developed for very-high-flying aircraft to fill in the gaps between ground- and ship-based tracking stations. At that time, headquarters turned them down flatly because ESD had only limited data on techniques and costs.

Since then, ESD has strengthened its position and currently has a contractor making a cost-effectiveness study of the AIP concept versus an improved ship- or ground-based tracking equipment.

ESD's technical studies show that, since an AIP system would be above most of the Earth's sensible atmosphere, velocities of ballistic-orbit objects within 100 n. mi. of the system could be determined to within 7 fps, and positions could be determined to within 0.6 n. mi.

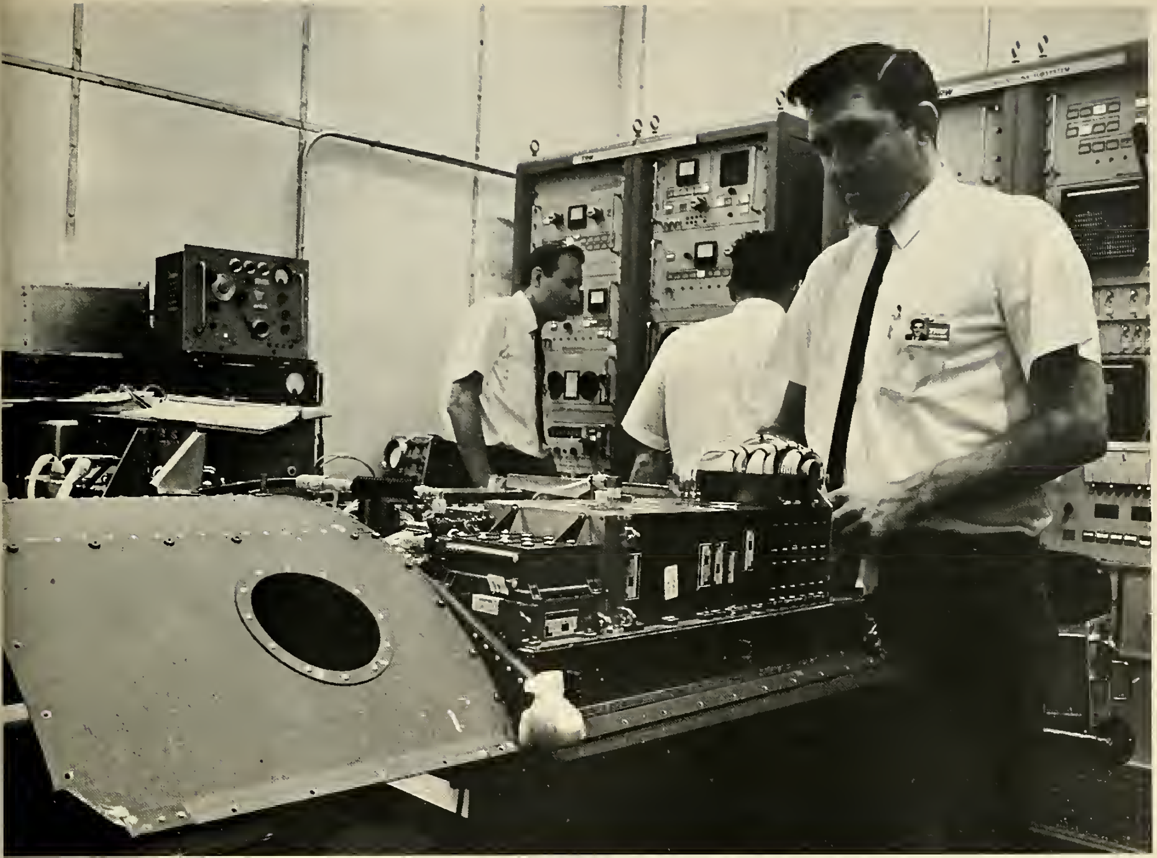
All the technical data, plus the cost-effectiveness information, will be presented to Air Force headquarters for evaluation this summer.

Apollo range instrumentation aircraft—In support of NASA's *Apollo* program, primarily the lunar injection-burn phase, ESD is directing the outfittting of eight C-135 aircraft with a variety of communications and telemetry equipment—15 tons per aircraft.

The 135's will carry voice-communications gear which will provide a direct voice link to the *Apollo* astronauts. Messages from the astronauts will be relayed from the A/RIA to NASA's Manned Spacecraft Center, Houston. Telemetry data from the *Apollo* module will be stored in memory equipment aboard the aircraft and then "dumped" via VHF transmission to ground stations. Other equipment to be carried includes two-way, high-frequency teletype systems, a nose-mounted, 7-ft.-dia. communications and TM high-gain antenna, and an airborne lightweight optical tracker (ALOT).

With the *Apollo* capsule parked in a 100-n.-mi. orbit over the Atlantic Ocean for lunar injection, three A/RIA aircraft, plus one backup, will be required. If lunar injection takes place over the Pacific, six A/RIA planes, plus two spares, will be required.

Four of the eight A/RIA aircraft will be capable of handling the ALOT system, but it appears that only one may be required. All the ALOT equipment will be housed in a 21-ft.-long pod mounted on forward left side of the aircraft fuselage. ALOT will be used to make detailed sequential photo-



Prototype Space-Ground Link Subsystem (SGLS) is shown during tests at TRW Systems, developer of tracking, telemetry and command subsystems. The SGLS project includes both the spaceborne package and the ground station equipment.

graphs of the missile and spacecraft during early launch, passage through high-dynamic-pressure regions, staging, separation and—possibly—re-entry.

All equipment for the eight C-135's, which are Government-furnished equipment from the Military Air Transport Service, is being acquired and tested now. One outfitted plane will be ready for the first unmanned *Apollo* shot this fall. Three others will be ready in early 1967, and all will be completed by January, 1968. Total program cost is approximately $30 million.

MOL support ship—The *MOL* program foresees a need for an instrumented ship, to be placed about 700 miles downrange from the launch area to cover the insertion phase of the *MOL* trajectory. The Air Force, in collaboration with NASA, is studying the possibility that one of the *Apollo* I & I range ships being modified for support of that program also can be used for *MOL* support.

Calibration studies—ESD is doing a series of analytical studies to determine the feasibility of calibrating range instrumentation from satellites. Plans have advanced to the stage that some C-band radar calibration equipment is tentatively scheduled to go aboard the *OV1-7* satellite to be put in equatorial orbit from WTR this summer.

If ESD gets the results it anticipates from this experiment, it will develop more equipment to calibrate other radars. This equipment would be put on a polar-orbit satellite to be launched early next year.

Communications systems studies—ESD is in a continuing effort to improve its inter-range high-frequency and wire communications links. This work is primarily basic technology, devoted to devising new modulation techniques, improving error-control and detection equipment, and developing data-handling systems with higher data rates.

EASTERN TEST RANGE

The eight new highly instrumented A/RIA jet planes and five new ships are being procured out of Eastern Test Range for ESD to improve telemetry and communications by the Air Force.

Although prime requirement for the planes and ships will be in support of the *Apollo* program, Air Force spokesmen feel the units will also have a limited use in future—and strictly military—space flights.

The A/RIA C-135 jets provide a cruising speed of 440 knots, which is sufficient to follow changes in orbital passes. The ships include three T-2 tankers, stretched at General Dynamics, Quincy, Mass., shipyards, and two C-2 transports, being modified by LTV, Inc. at New Orleans (M/R, Jan. 24, p. 24).

Both planes and ships will be operational by early 1968.

Air Force planners are now studying whether the 11 C-130 planes now in use can be completely replaced by the C-135's. At least five of the older planes will go to Western Test Range to replace five Navy Constellations now handling telemetry there. Present plans call for the Air Force to take over the telemetry functions for both the WTR and the Pacific Test Range at Point Mugu, using the transplanted C-130's.

As a part of the move from VHF to UHF at ETR, command frequencies will be shifted to the C-band (the 5,000 mc region) from the 400-500 mc region.

Air Force technicians expect less interference in the higher bands, partly because of the elimination of military radio traffic, and partly because of the higher directionalism of the antennas used at the higher frequencies.

At the same time, engineers are looking into ways of "stretching" frequencies, to allow a greater use of the bands.

But no sizable changes are being planned in basic equipment, according to William S. Hines, technical adviser for range engineering.

Embarrassment of data—One of the most difficult problems, he said, is what to do with the huge quantities of TM data collected during missile/space R&D launches. He predicts the machine-editing of the data received, using judgment factors programmed into computers. These factors would be sensitive to readings outside of certain parameters by specific amounts. When the higher- or lower-than-usual readings were found, they would be transmitted.

Two firms, Lockheed and Radiation, Inc., are prime movers in experimenting with this form of adaptive telemetry.

Col. M. W. Elliot, deputy for range operations, agrees. He points to the complexities being introduced into telemetry studies by multi-unit guidance systems, such as those built into the *Saturn* rockets. In these systems, outputs from three inertial guidance systems are transmitted to ground stations, where they are compared. If two of the outputs agree, but differ from the third, the third is assumed to be wrong. This information is used in planning flight programming and in forming destruct judgments.

On the ETR, primary work is concerned with stepping up capacities, rather than replacing equipment.

A new data and communications cable has already been installed between Antigua and Grand Turk Islands, and the International Telephone and Telegraph Corporation is in the process of continuing the line from Grand Turk to Cape Kennedy.

New computer plan—The Cape's future, as Elliot sees it, will include a new central computer setup. He sees one computer to service the needs of the entire Cape Kennedy-Patrick AFB area, using remote input and readout units at many locations, to replace the more than 50 separate computers now in use in the area.

Under his direction, the Air Force is now in the process of putting the control of all range facilities through a single computer. The setup will be used to program both the resources of the range, and the needs of range users, in an attempt to simplify, with printed schedules, total programming.

Eastern and Western Test Ranges now have their radar sets hooked up, via computers, so that they can "talk" to each other. This inter-range acquisition allows one radar, following a space ship or satellite, to tell the other precisely where to look when the object passes from one field of view into the other. The system has been in partial operation for almost three months, and full operation is due next year.

One major new installation at the Cape is the new Range Control Center, which will take over when Central Control closes and is turned over to Range Safety. In the new building will be complete equipment to handle all tests, launch control, aircraft deployment and display capabilities such as range status and missile progress. It includes the new satellite center, which is already in operation to monitor smaller scientific satellites.

SATELLITE CONTROL FACILITY

Support for Air Force space satellite operations is supplied by the world-wide Satellite Control Facility, which Space Systems Division spokesmen now describe as having the capability of supporting both equatorial and polar orbits. Six support stations are deployed around the world in the network: Guam; Vandenberg AFB, Calif.; Hawaii; New Boston, New Hampshire; Kodiak, Alaska; and on Mahe, Seychelles Islands, in the Indian Ocean off the east-central coast of Africa.

The Satellite Control Facility originally was intended for support of one Air Force satellite series and consisted of several ground stations and a control center. When other Air Force programs came along, the network was augmented with further stations and equipment—unfortunately, in many cases as a quick fix.

By 1961 a policy of more coherent development of the facility had been agreed upon and resulted in two overall trends—greater reliance on a high-capacity flexible computer system at the Satellite Test Center (the control point for the facility), Sunnyvale, Calif., and a movement toward increased standardization of ground equipment. The aim has been to obtain a standard set of ground equipment in which all changes in operation procedures can be achieved by computer re-programming.

Addition of new gear and rework of old gear has been restricted by scheduled support of space programs, which have been steadily increasing in number. However, the new computer system is now becoming operational and the development of standardized ground equipment is approaching reality with delivery of the first prototype Space-Ground Link Subsystem (SGLS) to the Vandenberg ground station.

General systems engineering and technical direction for the Satellite Control Facility is assigned to Aerospace Corp. Philco Western Development Laboratories has the hardware contract for the ground stations, other than the Satellite Test Center. Lockheed Missiles and Space Company has the hardware contract for the STC. System

Subsystem Standardization Push Continues

The Air Force is continuing its attempt to standardize subsystems in spacecraft and ground support equipment in order to reduce both costs and the variety of hardware. The most successful program to date appears to be the Space-Ground Link Subsystem, which is moving into the prototype flight-testing stage.

The Standardized Space Guidance System, which faded out of circulation about two years ago after a brief flurry of study contracts, has continued in spirit, if not in name, in laboratories at Aerospace Corp. and Wright-Patterson AFB, Ohio.

After evaluation of the original study contracts and possible mission applications, it was decided that aims for SSGS were premature and it was returned to the research phase. This has now led to the definition of four guidance system tasks, which have gone out or are going out to industry for bidding.

The first task is for systems studies, which are to be carried out by Aerospace Corp. as a continuation of previous work by the Massachusetts Institute of Technology and four other contractors. The second task, being re-evaluated during May, is connected with horizon definition. The re-evaluation is concerned with deciding what accuracy can be obtained.

The third and fourth tasks, coming from Wright-Patterson, are for a star tracker and an unknown landmark tracker. This last type of system provides additional information on a vehicle's path through space by observing any landmark and measuring the rates and angles with which it traverses the field of view. When these data are fed back into the trajectory, computations and improved trajectory can be calculated.

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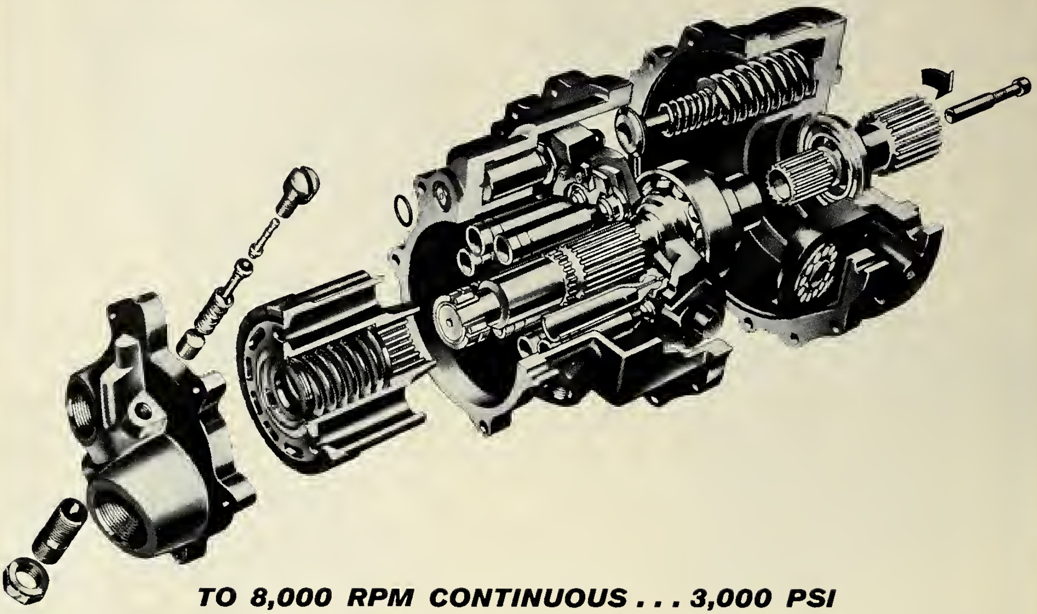

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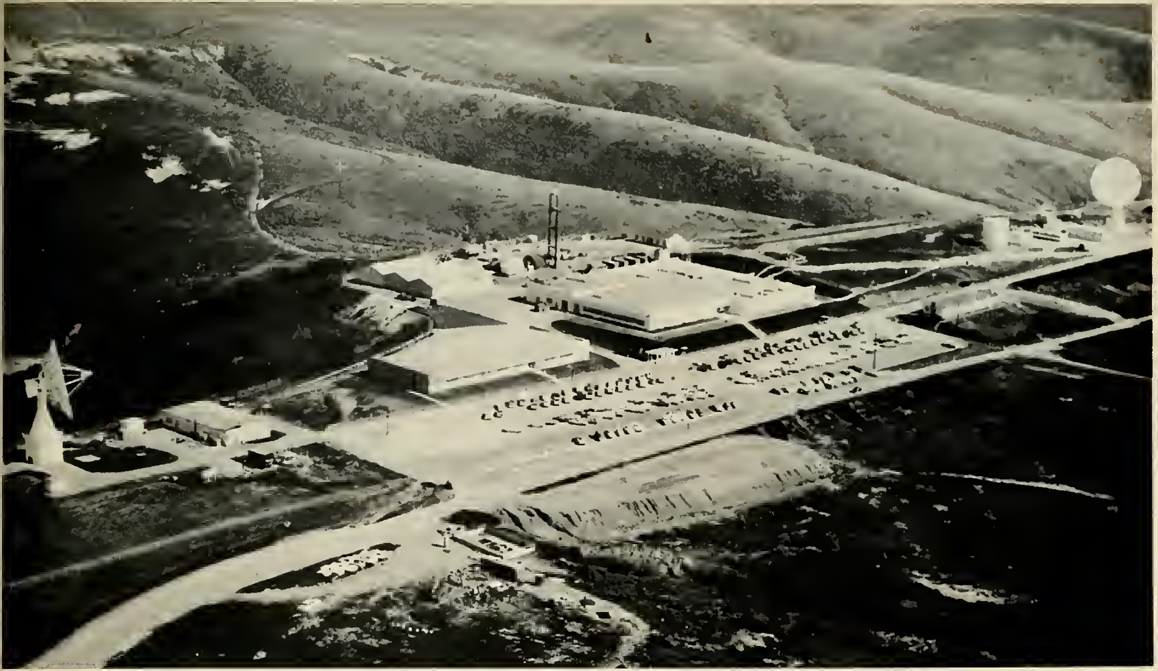

Satellite tracking station operated by the 6596th Instrumentation Squadron at Vandenberg AFB, Calif. The station performs telemetry reception, radar tracking and command and control functions. WTR is now moving into a wider variety of space activities.

Development Corp. has the contract for computer program integration.

On-line operation—One of the chief features of the SCF is the on-line data transmission that takes place between computers at the remote ground stations around the world and the computer at the STC. Computers operate on-line at both ends of the data link. Parallel digital data words are transformed into serial words, encrypted, and tone-modulated for transmission.

On-line computer programs at the ground stations digitize, compress and format FM/FM telemetry data received from satellites, prior to transmitting it to the STC. The ground stations also check tracking data for quality, compress them, and transmit them to the STC for orbital calculations. In the opposite direction of transmission, commands for satellites that are transmitted from the STC are verified at the ground station and transmitted to the satellite, and receipt of the commands is sent back in real time to the STC for further verification.

At present, the various ground stations have different mixtures of telemetry and tracking equipment, which SSD spokesmen describe as very similar to standard range equipment. Operating frequencies include VHF, UHF, and S-band.

Two of the more standard antennas that are to be found in the network are the 14-ft.-dia. Prelort for accurate beacon tracking and the 60-ft.-dia. paraboloidal antenna for communication with high-altitude satellites. Usually one antenna is being used for command while another is being used for telemetry. To relieve the burden of telemetry from the paraboloidal tracking antennas, a dipole array is often used. All but one station is equipped with an instrumentation radar; four stations have the 60-ft.-dia. antennas.

SGLS—By going to a standardized Space-Ground Link Subsystem (SGLS), SSD hopes to reduce the amount of ground station equipment significantly. This subsystem will operate at S-band frequencies, to which the military will switch by 1970, and will enable the ground stations to standardize on two antennas.

The SGLS is made up of the airborne equipment and ground station equipment required to handle telemetry, tracking, and command. These three functions are carried over a frequency-multiplexed link. Use of digital techniques is extensive, and includes the telemetry, where PCM replaces FM/FM. As a result microcircuit construction techniques, using both integrated circuits and hybrid circuits, can be applied to the flight hardware, with significant reductions in size and weight, and increases in reliability.

By use of a modular form of construction, the specific telemetry, tracking and command requirements for each of SSD's systems program offices can be built up. Flight modules bolt together and are approximately 7 in. by 4 in. by 1 in., weighing about 1 lb. The SGLS also has the capability of transmitting a number of channels of voice, and is expected to be used in the *Manned Orbiting Laboratory*. By agreement with NASA, the SGLS is compatible with the agency's Unified S-Band System on the down link.

TRW Systems Group, contractor for the prototype ground and flight hardware for the SGLS, has delivered one set of ground equipment to the Vandenberg station of the SCF, including the PCM ground decommutator and interface unit for the ground station's computer. Another set of ground equipment, four flight units and four back-up flight units are due to be delivered imminently. The flight-test phase is likely to be entered into fairly rapidly, to provide information on which a production decision can be based. Piggy-back rides on other military space programs will be exploited.

WESTERN TEST RANGE

New ballistic missile programs, increased Air Force unmanned satellite operations, and the advent of manned launches are leading to increased sophistication in the support facilities of the Western Test Range. A decision on a new modular computer central is expected this summer, plans are being drawn up for a new telemetry central,

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a new tracking radar site is slated for the *MOL* launches, and greatly improved instrumentation facilities are planned for the Eniwetok lagoon.

WTR is in fact becoming less of an operational Strategic Air Command launch site and more of a common user facility for a wide variety of space activities.

Since much of the new equipment foreseen for the Vandenberg headquarters of the range will be highly automated, only a modest increase in personnel is expected over the next few years.

"There is also a real need to be able to tie in WTR in real time to the global network, which calls for precision timing," said range commander Brig. Gen. J. S. Bleymaier.

At sea—The range's requirements also are expanding in the open ocean. There are now 10 ships under operational control of WTR. Five are *Apollo* ships and two are satellite recovery ships based in Honolulu.

"The predominant operation has changed from SAC operational firings to space and R&D firings," noted Stanley R. Radom, technical director of Western Test Range. "As a result, we have had to become more sophisticated in our instrumentation. Whereas we previously had research and development shots confined to the Cape, there are now space systems and boosters fired here for the first time."

"We have to man rate our support instrumentation for *MOL,*" he added; 'we need higher reliability and redundancy to avoid drop-out of critical data. We are looking at the geometry for manned polar launches and revising our instrumentation plan. We need very accurate impact prediction for the *Titan III-C* boosters and also for astronaut recovery in the early phases of *MOL* flight."

Radom added that WTR was not likely to duplicate anything at the Cape, although it is starting to receive certain types of instruments from the Cape for use at Vandenberg and in the impact area.

"We will not go to sophisticated instrumentation like Mistram or Azusa and that family," said Radom, "because we do not yet have the requirement for guidance evaluation."

Slow growth—By a scheme of trilateration, using existing radars, the tracking accuracy for both polar and westward launches will be raised. Then pulse Dopler techniques will be used to further increase capability. But the improvement will proceed slowly, keeping new instrumentation to a minimum.

Main tracking radars at Vandenberg are two FPS-16 units on Tranquillon Peak, and a TPQ-18 radar closer to the pads at South Vandenberg, having the same characteristics as the FPQ-6. This radar was procured for accurate tracking of *Minuteman* and for upgrading the range in general.

For *Atlas* and *Titan* launches, which can carry a suitable transponder, an X-band General Electric Range Tracking System (GERTS) provides both tracking and rate data for range safety.

Because of the high flame attenuation of radar signals expected from the big solids in the *Titan III-C,* the geometry of the radar tracking stations will have to be altered. For westward missile launches, FPS-16 radars at Point Pillar, near San Francisco, and on San Nicholas Island have circumvented the flame attenuation problem met by the Vandenberg radars. For the southerly *MOL* launches, however, a new radar site will be needed.

Computers—There are Univac 1218 computers at three of the instrumentation sites and a RCA 4101 at the TPQ-18 site. These are coupled to an IBM 7094 at South Vandenberg for present position digital data and for instantaneous impact prediction on Western launches and for some southerly launches.

By December the 7094 will be replaced by an IBM 7044, which has faster access and larger storage capacity. The other large computer will then be used exclusively for post operations analysis. The central computer now provides instantaneous acquisition data for the instrumentation sites. Data is transmited at 10 pps. The present computer does not make use of data from off-shore facilities.

A study of the optimum configuration for existing and future requirements for computers at the Vandenberg headquarters of WTR suggests that a computer center serving all range requirements by use of a modular central processor will be required. A final decision on this is expected this summer. System Development Corp. has a contract to analyze WTR computer requirements.

Range control factors—In the Range Control Center, the range control room is currently set up to enable two launch operations to proceed at the same time. Simultaneous launch, however, depends on compatible instrumentation on the two missiles. Within the range control room, the range control officer provides the single point of contact betwen the user and the range. He is responsible for the data collection by WTR. Responsibility for flight safety rests with the range safety officer.

A new range control room under construction will provide a capability of four simultaneous launch operations, having a total of 16 plot boards in the range safety area. There will be two

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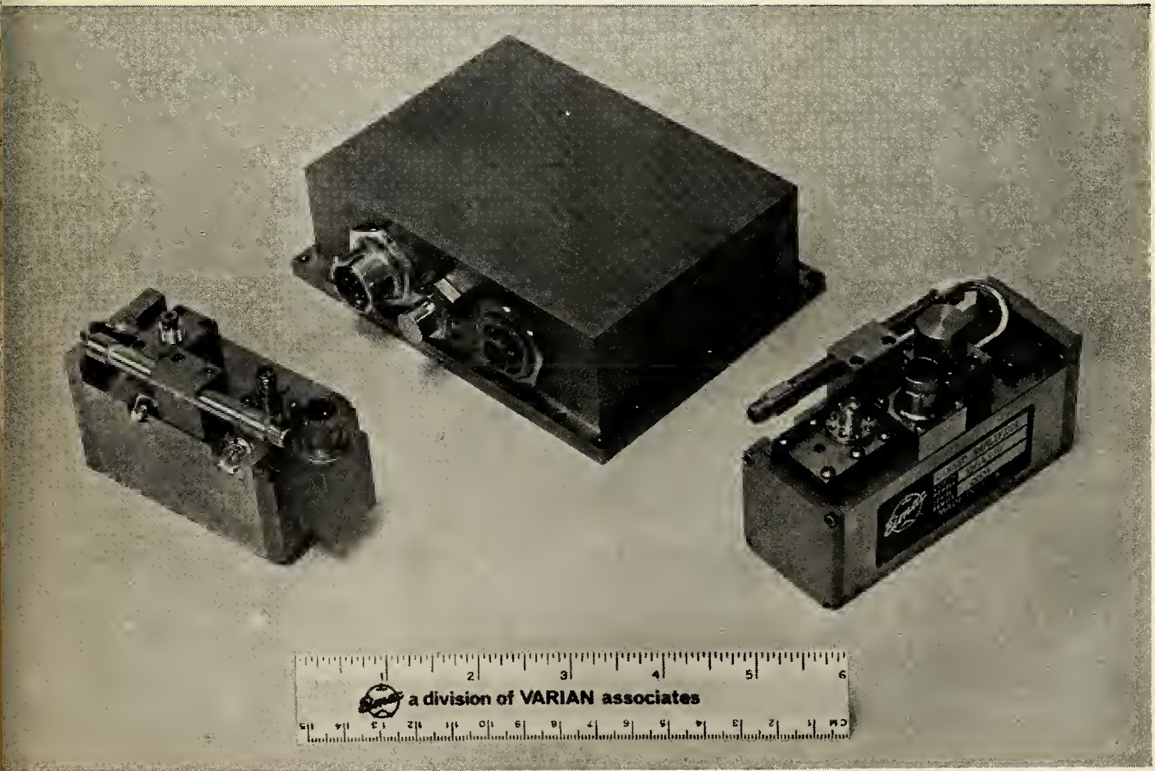

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range control officers, one for each pair of launch operations. This new room should be in use later this year.

Telemetry—Instead of expanding the telemetry station at South Vandenberg, WTR has expanded the telemetry central operated by the 6595th Test Wing. That is, one center has been expanded to become a Range Telemetry Central rather than fragment the facilities.

The telemetry central has decommutator units for all range user requirements. Also, it has a predetection recording capability using Defense Electronics Inc. pre-detection receivers and translation units. There is a very large and comprehensive system for closed loop and open loop testing, but the present RTC represents only a first step. Establishment of a central computer facility would make it logical to move the RTC to the same location and provide separate rooms for each user, with individual displays for both pre-launching check out and real-time flight data. By locating the computer central close to the telemetry central, full use of real-time digital readouts can be made.

A study is in progress to decide on the final configuration desirable for the telemetry central. The present system allows direct readout during pre-launch closed-loop testing, chiefly for ballistic programs; but it will be expanded for use with space boosters. It will not, however, get into space payload testing, as the payload developer has facilities for this.

To meet the needs of *Titan III-C* launches, a telemetry station is being moved to a ridge overlooking both the new and existing launch sites for the vehicle. ■

Defensive Systems

Advanced Anti-Satellite System in Offing

Washington—The Dept. of Defense is expected to move toward development and deployment of an advanced, ground-based, anti-satellite system.

High-ranking DOD and Air Force officials told Missiles and Rockets a firm go-ahead for a new system could come within two to three years.

Though very little funding for such a system is included in the Fiscal Year 1967 DOD budget, a highly important study of the entire question of satellite defense is now being carried out and is scheduled for completion before submission of the FY '68 budget. The program could get its first important funding in that budget.

The U.S. now has two operational anti-satellite systems (M/R, May 11, 1964, p. 12). One is made up of *Nike-Zeus* missiles and radars and is situated within the *Nike-X* complex around Kwajalein Atoll in the Marshall Island chain. This system, according to DOD, has been operational since 1963.

An Air Force system, operational since 1964, is built around the *Thor* missile and is based at Johnston Island at the southwest fringe of the Hawaiian Island group.

Defense officials, while stressing that these two systems have very real orbital-intercept capabilities (M/R, Nov. 15, p. 14), admit that they are basically "cold war" weapons, built in response to early Soviet threats of orbital weapons and 100-megaton bombs. This early U.S. capability was also achieved at comparatively little cost, using existing boosters, radars and launch sites.

Written by Associate Editors Michael Getler and Rex Pay.

Something better—For the past several years, DOD and the services have conducted many studies, some in-house and some through industry, on a variety of schemes for an improved system.

The Army, for example, has been asked to study what the anti-satellite capabilities would be for its proposed *Nike-X* anti-ballistic missile (ABM) system—if it is deployed.

Defense officials stress that there is no thought of deploying the long-range missile component of *Nike-X* solely as an anti-satellite weapon, independent of its ABM role. They point out, however, that if the *Nike-X* ABM system is deployed, the Army will automatically find itself in the anti-satellite business.

The new long-range version of *Nike-Zeus* would provide some capability to take out satellites in relatively low-altitude orbits, out to perhaps 200-400 mi. Since it is not likely that orbital weapons would be deployed in very-high-altitude satellites—if they ever were deployed—the *Zeus* component could serve some purpose.

However, the principal anti-satellite protection seen for *Nike-X* is in bringing down any de-orbited warheads aimed at the U.S. Its job in that role would in most cases, be easier than bringing down ballistic missile warheads, since presumably it would have been possible to gather some tracking data on the satellite weapons-carrying platform.

The main thrust of the DOD anti-satellite effort, however, is to develop a new system which clearly would extend U.S. in-orbit interception capabilities.

AF responsibility—Because of this, the Air Force is expected to play the key role, taking into account whatever capability should be forthcoming from *Nike-X* and also using the considerable body of data developed by the Navy on sea-based anti-satellite systems.

Navy studies have included use of *Polaris* in an anti-satellite role and have made heavy inputs regarding the potential for mobile launch platforms able to range to virtually all Earth latitudes. This would allow interception in orbits normally beyond the reach of fixed sites located near the equator.

Air Force studies now in progress are concerned with a wide range of in-orbit intercept plans. No new boosters are required, but the concepts under study range from use of improved *Thor* vehicles through the *Titan III*, which would provide capabilities against satellites at synchronous altitude.

Air Force, in particular, and the Navy are also looking into a variety of new booster front ends which match terminal homing systems, if needed, with the type of warhead selected.

Taking shape—Exact configuration is unsettled, but defense and Air Force officials say certain system characteristics are being formed.

These officials remain convinced that an anti-satellite system, in which the object is to destroy, rather than capture or inspect, the satellite, is still best accomplished from the ground rather than from space (M/R, Oct. 28, 1963, p. 19).

The system is likely to involve a direct-ascent, cross-course intercept.

The need for terminal homing is tied directly to the type of warhead used. A nuclear warhead obviously has greater lethal range and would therefore cut down on guidance requirements and costs. A conventional warhead would require considerable vehicle maneuvering to the target, which is more expensive. However, this provides a more clandestine operation: the country that owns the destroyed satellite will know it has been attacked, but the rest of the world won't.

Defense officials stress that competitive costs will be highly influential in system selection.

The system is also apt to be deployed at a relatively small number of sites along the near-equatorial latitudes, which will allow the greatest number of orbital intersections, but which probably would not cover all types of possible hostile satellite orbits.

The system would also continue to use inputs from the existing SPADATS (Space Detection and Tracking System) network, which officials say is highly accurate and would require very little, if any, modification.

Decisions on deployment of space weapons systems are closely related to overall defense policy and to alternative forms of the other weapon systems with which they are competing. However, it can be said that, in general, space weapons do not look attractive in the context of a massive nuclear exchange of the "spasm" type.

Nevertheless, space-based defensive weapons may have certain advantages in conflicts that do not reach this level.

Illegal, but . . .—Stationing weapons of mass destruction in space is illegal, according to a resolution passed by the U.N. General Assembly. However, the use of illegal weapons and the production of them have always been considered two different matters. Hence, when the U.S. queried the Soviet announcement of an orbital rocket that could strike on the first or any later pass around the Earth, it was not surprising that Russia replied that the U.N. resolution did not forbid production of such weapons.

How far the Soviet orbital weapon has gone from research into production is, of course, a matter of speculation. As an offensive weapon its distinctive feature is its basing, and it is hard to see what advantage an orbital base has over a ground site or a submarine. To any such system that remained in orbit for any length of time would accrue the disadvantages of being precisely located by the enemy and inaccessible to repair in the event of failure. It would also be prone to cumulative degradation of onboard electronics. Furthermore, it probably would require a command system that would be vulnerable to interference.

If the weapon made only a few orbits or only a partial orbit before striking, its chief advantage would be its ability to strike from an unexpected direction. The accuracy of the orbital system would be poorer than that of a direct-flight missile, unless it had terminal guidance or was accurately tracked for an orbit or two and operated by command. If it was commanded in this way, however, the defense could also track it.

It is conceivable, of course, that a satellite (like an ICBM) might deploy warheads in lifting bodies. The main advantage these give is an increase in side range; there is a loss in accuracy, however, and some form of terminal guidance probably would be necessary.

An orbital anti-satellite weapon is much less feasible at this time than a ground-based system (though the Air Force continues to study it), and its realization will require considerable developments in the technology.

At present, then, the chief reason for U.S. deployment of anti-satellite systems—apart from the general policy of developing hedges against vaguely perceived threats—is admittedly to deter interference with single vulnerable satellites, such as *MOL,* and to reassure the civil population that defense against space threats, real or imaginary, is being taken care of.

Other means—Protection of satellites in space for long periods of time appears, at present, to be exceedingly difficult. It is likely that means other than active defense, notably the use of backup systems and deterrence, are the best counter against the threat of attack. If military ground systems become increasingly dependent on space systems for support functions such as communications, navigation, surveillance and observation, backup systems will be essential. Deterrence will remain in the background, however.

At present, satellites usually can be identified from the ground after some time; in the current environment there is no urgency for orbital inspection. However, if the U.N. agreement were broken and orbital weapons deployed, a greater concern for satellite identity might develop. This, however, would be a space environment different from that we have today, and the world political/military situation might also have changed—that is, there might be other requirements more pressing than inspection of space weapons.

In the absence of this situation, leaving curiosity as the only motive, the expense of an operational orbital inspection system currently appears to be high enough to rule out its deployment.

The *MOL* program, which is apt to involve development of extensive orbital maneuvering capability, either by the entire vehicle or by the *Gemini* capsule, or by a remote maneuvering unit, is expected to provide the major realistic assessment of whether or not orbital inspection and interception schemes are indeed feasible.

Identification of satellites from the ground involves the gathering of many incidental types of intelligence—vehicle payload weight, number of vehicles in system, type of orbit, lifetime, types of transmission, shape revealed by radar and optical observations, type of stabilization and time of launch.

Defensive pros & cons—Although satellite-based *offensive* weapons appear to have no special advantage at this time over weapons based elsewhere, satellite-based *defensive* weapons could become useful in certain situations.

Studies have been made of a satellite-based boost-phase ABM system in which a surveillance system would be integrated with an interceptor system. If one ICBM were launched there would be advantages in intercepting it during the boost phase. Its speed would then be lower than that ultimately reached by the warhead. It would be clearly identified by its rocket exhaust. If a nuclear warhead were used to destroy the missile, it would explode over the aggressor's territory, and he would have the fallout problem. Finally, this represents a very precise response—a strike at the selected tool of aggression.

The drawback of a system such as this, apart from the basic technological problems in getting it to operate, is that it is very vulnerable to saturation. It could not easily track and intercept a large number of missiles if they were all launched together. Thus the system has a role in low-level nuclear conflicts, but not in an all-out "spasm" conflict.

Pressure builds—Though they admit that there are large technical problems, high-ranking Air Force officers feel strongly that the door which was shut on space-based ABM systems needs to be reopened.

In particular, Air Force generals cite the ability demonstrated by the *Gemini 5* astronauts to visually track ballistic missile launches. It is felt that electro-optical systems, possibly using lasers, could acquire and track missiles early in the launch phase and provide beam-riding guidance to intercept.

Though a new ground-based anti-satellite system looks certain, action on the *Nike-X* ABM system is expected to come before the hardware-stage decision on an anti-satellite weapon.

As one official puts it: "We have spent about $32 billion on defense against attack from the air, a threat which is diminishing but for which we are prepared; we have spent $2 billion on anti-ballistic missile technology, a very real threat for which we have no defense; and we have spent very little for space defense, from which there is no threat—yet we have a defense. I think we will probably balance the ballistic missile threat next." ■

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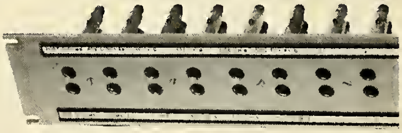

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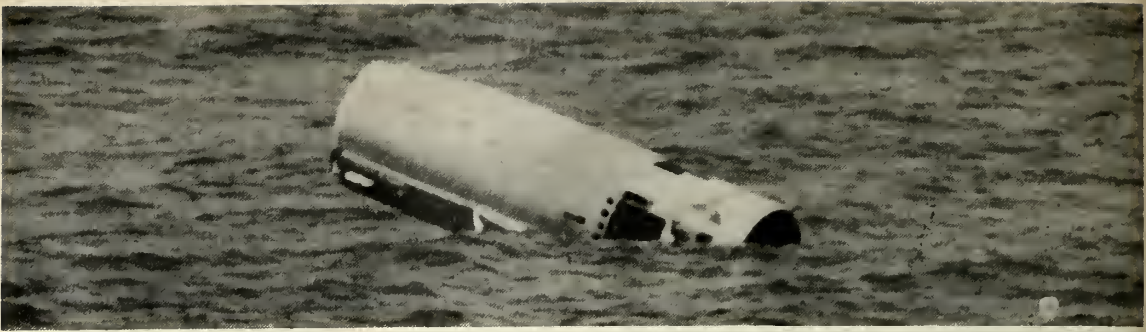


Titan II first stage floating in Atlantic Ocean after successful mission from Cape Kennedy. Launches such as this have shown that maximum stage damage occurs at water impact. Planned use of Titan II stages is extensive enough to justify minimum-funded project to investigate recovery and refurbishment to establish firm cost projections.

PART III: RESEARCH & TECHNOLOGY

Supporting Research & Technology

Lack of Funding Worries Air Force

WASHINGTON, D.C.—The technology base designed to support military space functions is rapidly shrinking. One high-ranking Air Force official says the "account" is being tapped without being replenished, especially in the broad area of materials and in Scramjet technology.

Funding in both areas is considered inadequate. Military space programs such as the *Manned Orbiting Laboratory (MOL)* and lifting body technology may be exhausting the state of the art, according to military experts.

Dept. of Defense officials expect *MOL* to spell out future areas of technology. The present Air Force START (Spacecraft Technology and Advanced Re-entry Test) program in maneuverable re-entry is designed as a technology program.

But it is obvious where the general problem areas will be—for example, in higher performance structures, both in loading and temperature; in new fuels and propulsion concepts; and in revamped disciplines such as the marriage of aerodynamics to space operations.

Specific problem areas are difficult to define without aiming at missions, or even general mission areas. This type of effort is hardest to sell to DOD.

Familiar examples of technology funding problems are the Air Force's current 156-in. solid, NASA's 260-in. solid, elements of supersonic combustion (which lead to the Scramjet family and ultimately to a ground takeoff to space) materials and structures.

Without detailing the decision problem within a limited budget, compounded by the many other priority DOD missions, the fact remains that there is concern with the current level of DOD technology support.

Written by Senior Editor John F. Judge and Associate Editor Willard Wilks.

MATERIALS RESEARCH

A prime example of this is in the materials program as now defined by the Air Force. This effort is based on results of years of analytical studies, which indicate that even marginal success in many of the sub-programs involved will result in dramatic improvements in materials performance.

There is a good chance that better-than-marginal results can be expected because the program has not yet found a technical plateau. It keeps growing in a continuous stream of technological advances.

Analyses conducted after the boron filament/composite research breakthrough occurred indicated massive improvements are theoretically possible in all applications areas studied with respect to high-performance, lightweight structures.

These studies included airborne structures, aircraft engines, space and re-entry vehicles, rocket propulsion hardware, helicopter rotor blades and propellers.

In the words of one Air Force materials official, "It would be naive to expect realization of the full potential in even a single applications area.

"This seldom occurs, but certainly the overwhelming potential of these materials warrants comprehensive effort to rapidly develop and exploit technology," he continued.

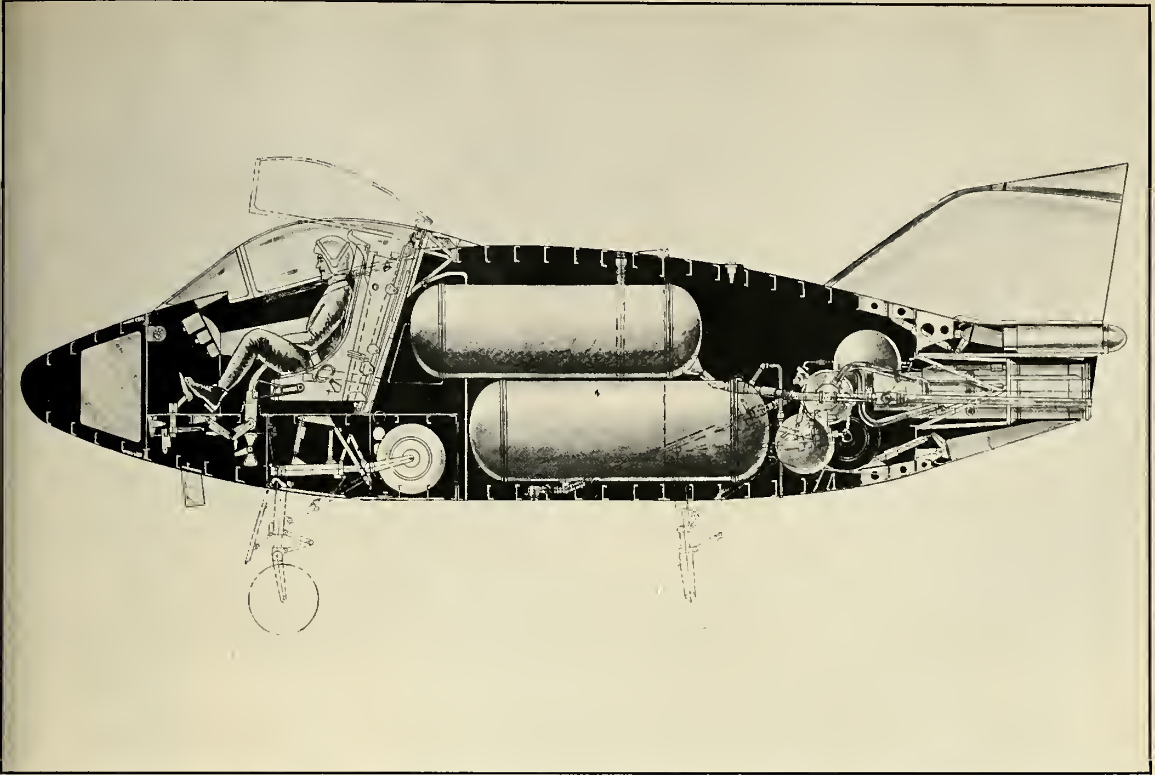
The major variable is money. This controls the speed and degree of the effort. There are no technical barriers now in sight.

Filaments and composites—The Air Force has created an active, complex and far-reaching program under the general heading of High-modulus Filaments and Composites.

The primary aim of this effort is to project improved structural composite components into operational applications. The operative word is composite and the Air Force is still fighting some industrial parochialism in this area. Proponents of individual fibers, filaments, flakes and whiskers abound in a market created by a customer looking for composites. The attitude is changing.

The program essentialy bridges exploratory development to actual systems applications. Operating out of the Materials Laboratory at Wright-Patterson AFB, Ohio, under Col. L. Standifer, all activity is being oriented to support the development of actual advanced composite componentry.

Three main areas—There are three primary elements within the program —component development, filament de-



Air Force PILOT vehicle shown with propellant tankage and systems designed to feed Thiokol Chemical Corp. Reaction Motors Div.'s XLR-11 engine. Engine shown is the same unit used to power the X-15 before installation of the XLR-99 engine. Landing gear may be either skids or wheels. Efforts are under way at Edwards AFB and Martin-Baltimore (company-funded) to install a jet engine in the vehicle for ground takeoff instead of a drop from a B-52. Jet engine would allow for more flights through the immediate landing regime of interest to pilots at less cost than drop-flights from a B-52.

velopment and composite materials development.

The first area includes component demonstration, component-oriented technological building-block solutions, and development of new structural design concepts.

The area of new design concepts is especially critical. Concepts specifically tailored to available materials capabilities, available fabrication procedures and the functional requirements of the component must be developed. A major area is multi-directional loads.

George Peterson of the Materials Laboratory feels it is painfully clear that structures with complex loading situations impose severe limitations on structural composites. These multi-directional loading effects may not have been critical with homogenous materials.

"Every step the designer can take to either reach or approach uni-directional structures is a vital one in regard to improved performance. We must force the designers in this country to exercise their ingenuity and to help themselves to the design of vastly improved structures," he said.

The filament development effort attacks the basic materials problem area and only initially reflects a heavy concentration in preparation of boron filaments.

The Air Force will continue to push for low-cost, high-production-rate, high-quality filaments. Chemical-vapor deposition, direct-melt spinning, corona-discharge and dip-coating techniques are under active development.

Boron filaments are the first of many such reinforcing agents. The program involves carbon, silicon carbide, boron carbide and others.

The composite element consists of material development, composite materials design and development of fabrication procedures for advanced composites. A key area here is the matrix material and filament treatment development.

These conditions will be defined so that they will be responsive to the requirements of the particular structural component items being developed. Early emphasis is on extending the capability of organic-type matrix materials to use past experience, processing and fabrication advantages.

Immediate goals are a better match of filament and matrix properties, improved shear strength and higher temperature capability.

Production methods—Fabrication techniques are a major factor in determing final costs and have a pronounced effect on the performance and integrity of the finished structural component.

Initial emphasis here is on developing revolutionary new techniques for organic matrix composites. These methods must initially be able to handle glass and boron filaments and other new filaments coming up in the future.

The procedures should be able to accommodate several filament materials in selected volumes and orientations—including three-dimensional configurations.

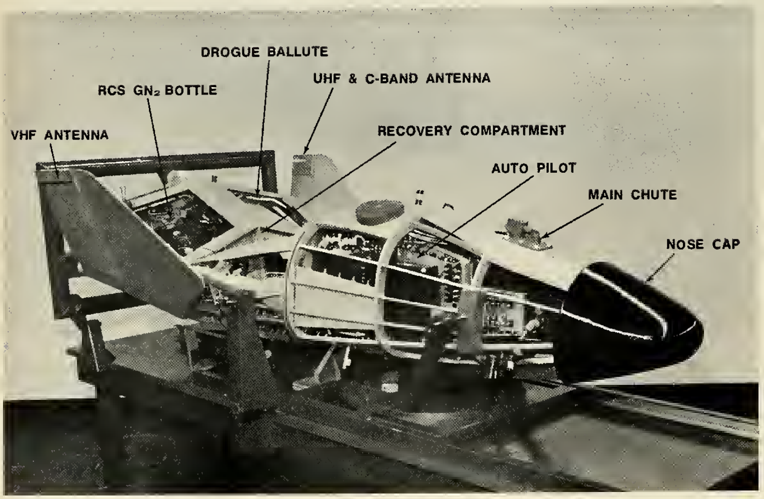
Engineering data efforts are oriented to develop the most meaningful design and engineering information for structural engineers. A prerequsite is development of valid test procedures that convey the information necessary for the design of component structures.

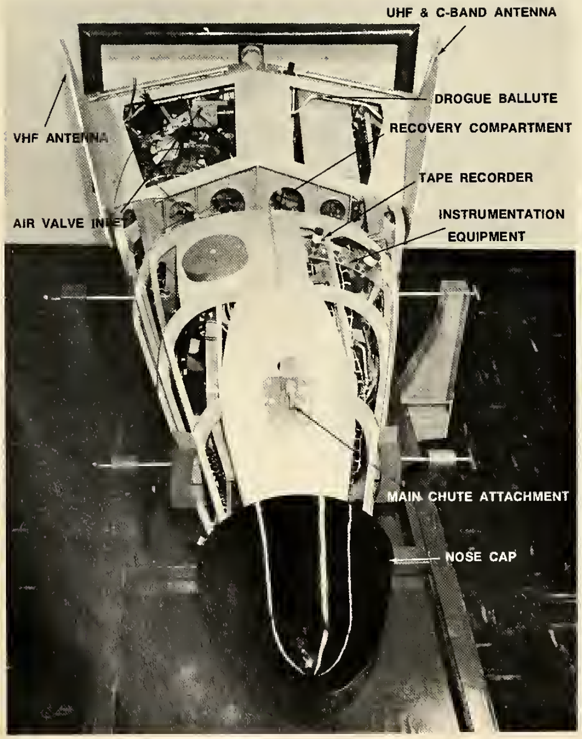
The data base generated will closely reflect the materials configuration and properties of greatest interest to the designer. This base of data will be supplemented by specialized tests. A program is being planned to develop nondestructive test procedures and techniques for effective collection, collation, analysis and, finally, dissemination of all data generated to the aerospace industrial community.

The approach taken by the Materials Lab planners has many facets. All are interrelated. The essential task is to compress centuries of normal progress into a few years of intelligently planned effort. Materials progress had always been sporadic until the recent explosion spawned by space activities. The spillover into other areas such as aircraft and naval vehicles is now visible.

LAUNCH VEHICLE RECOVERY

The *Titan* program may soon be expanded to encompass a project to define some of the cost problems associated with recovery and refurbishment of booster stages.





Boilerplate models of Martin's PRIME vehicle showing position of all associated components necessary for the four PRIME launchings from Vandenberg AFB. The vehicle itself is part of a technology program designed to establish flight and other operational characteristics needed for the functional design of a manned maneuvering re-entry vehicle.

Military space experts are examining a Martin Co. proposal to recover three *Titan* first-stage core vehicles. The proposed effort is cumulative—recovery aspects are exactly the same in all three cases but the first core will be tested to destruction.

Information from this portion will feed into a second recovery in which the reclaimed stage will be refurbished, static-fired and then examined. If the results are good, the third element will involve recovery, refurbishment and relaunch, followed by recovery.

The basic idea is to define the costs involved and finally achieve a reasonably hard set of data points through a relatively economical program. Planners do not have enough information to intelligently approach the recovery question with present launch vehicles. Refurbishment cost projections are especially soft.

Elements included in the Martin approach start with a *Titan III* core (*Titan II* first stage), a Sikorsky CH-54A Flying Crane helicopter, Northrop's Cloverleaf gliding parachute, All American Engineering's aerial recovery equipment, and commercial Army barges or a Navy mothballed "Jeep" carrier. Total cost for all three elements of the program is about $3.6 million.

Cost savings seen—If the approach proves itself and Martin/Aerojet refurbishment estimates prove accurate, the potential net savings per launch vehicle is $800,000—including initial vehicle and recovery costs.

The recovery effort will not affect the primary missions in any way. There will be some structural changes to the *Titan* first stage including addition of a new external ring frame and short longerons, and an external pod containing the recovery components.

There is no change in second stage or *Agena* payloads, no effect on the booster payload environment, no change in vibration and boost dynamic pressure, and no change in control authority and staging.

There will be no calculable change in primary mission reliability. There will be an 18% increase in stage I aerodynamic drag and a payload weight degradation of 193.7 lbs. These are not appreciable effects on total payload performance.

The recovery would be air-snatch via helicopter. Current booster impact predictions have proven accurate enough to allow Martin planners to pinpoint almost exactly the helicopter location area.

The program calls for practice recoveries by the Chinook over several

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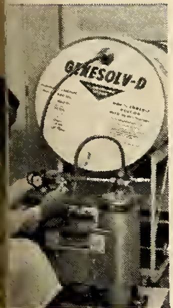

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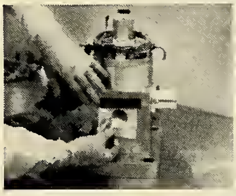

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*MSFC-SPEC-106 A, MSFC-SPEC-164 AMENDMENT 4, KSC-C-123 (D) and others.

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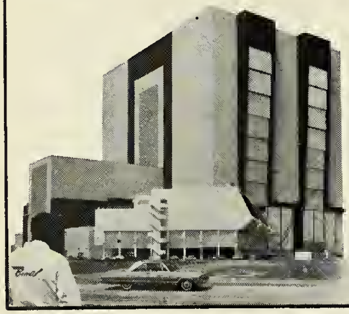

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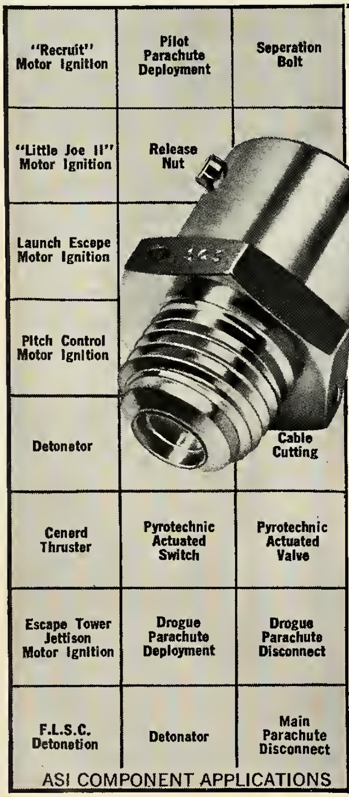
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weeks of training flights, gradually leading up to the 17,000-lb. pickup ability needed to handle the *Titan* first stage.

Fringe benefits of the program include confirmation of current booster design and discovery of methods to make expendables cheaper. By itself, the Martin effort would increase aerial recovery capability by a factor of 3 to 4.

Besides refurbishment cost information, the program would provide hard data on one mode of recovery operation, handling techniques and procedures, refurbish, re-test and inspection requirements and the effects of re-use on hardware and its reliability.

It is known that by far the most damage inflicted on a returned launch vehicle first stage occurs during impact. The worst re-entry conditions faced by any booster stage are less damaging than the effects experienced during powered flight.

After a successful snatch by the helicopter, the stage is delivered to a nearby surface vessel where the destruct system would be removed, engines lightly purged and the whole stage washed down with fresh water.

More thorough propellant drainage and purging would be handled at dockside before overland shipment to Martin/Denver for refurbishment.

LIFTING RE-ENTRY

Another major military technology program is the Spacecraft Technology and Advanced Re-entry Test (START) effort. Almost $120 million has been spent to date—from inception of the first element of this program, *Aerothermodynamic Elastic Structural Systems Environmental Tests (ASSET)*, to the present work in the two remaining elements—Precision Recovery Including Maneuvering Entry (PRIME) and Piloted Low-speed Test (PILOT).

START is concerned with exploring and determining the practicability of operating in the environment over and above conventional aircraft. This essentially is lifting re-entry, manned and unmanned.

The whole technology began when scientists at NASA's Ames Research Center proved bodies had lift. Both PRIME and PILOT are being developed for the Air Force by Martin/Baltimore. Air Force Systems Command's Space Systems Div. is managing PRIME while Aeronautical Systems Div. is now responsible for PILOT.

The PRIME vehicle, Martin's SV-5D, is an unmanned, medium-length/diameter-ratio maneuvering lifting body designed to demonstrate maneuverability through hypersonic velocities on re-entry from orbit to subsonic velocities on landing. It will also perform cross-range maneuvering, ending in precise recovery.

Launched by *Atlas SLV-3's* from Vandenberg, AFB, Calif., PRIME vehicles will be recovered by air-snatching in the Kwajalein Island area.

There are four launches planned, with the first expected late this year.

Hundreds of tests on various configurations in many of the aerodynamic facilities in the U.S. were performed by Martin, NASA and the Air Force before the various configurations were chosen. While the Air Force is funding the Martin efforts, NASA is researching a set of lifting bodies with the Northrop Corp.

Program details—The PILOT program and NASA's efforts will join in a combined series of tests planned at Edwards AFB, Calif. All data flowing from the PRIME program will be shared with the space agency. Specific configurations include the Ames M-2 vehicles and the Langley Research Center HL-10 vehicles as well as the Martin SV series.

There are three major problem areas being researched in the PRIME program—shape, guidance and control, and re-entry heating. The guidance and control details are largely classified.

PRIME is basically a conventional arrangement of aluminum skin, stringers and frame covered with a Martin-developed low-density, fiber-filled silicone elastomer ablator. The higher temperature areas such as the fins are covered with beryllium faces. The thermal protection of the flaps as well as the nose cap and body leading edges is a carbon phenolic ablator. The fins use the same silicone elastomer as the body itself.

The PILOT vehicle is a one-man version of the SV-5 lifting body. One unit will be built and used to explore the flight characteristics and maneuverability of wingless lifting bodies from Mach 2 down to landing at normal jet fighter speeds.

The PILOT vehicle will be flown at Edwards in a joint NASA/Air Force test program.

Although planned tests start with unpowered, manned gliding flights after being dropped from a B-52, later drop-flights will be powered, using the XLR-11 rocket engines originally designed and flown on the *X-15*.

Edwards AFB is expected to request the addition of jet engines to the SV-5 to allow powered take-off. Indications are that this method costs less than using B-52 aircraft—especially in flying from the ground to 25,000 ft. and then concentrating on piloting the vehicle back down. More flights could be scheduled in this manner and the Edwards pilots feel the landing aspects need attention.

The original PILOT plans involved two vehicles—one rocket-powered and the other using a jet engine. Funding prevented following both and only the rocket version is currently authorized. Martin is spending its own funds to develop a jet-powered, manned SV-5.

The whole START program is severely constrained by fund limitations, as is PILOT. The main theme is to use as much conventional or available equipment as possible while still meeting the overall objective of defining manned lifting re-entry technology.

Together, the PRIME/PILOT combination is expected to establish flight characteristics in a totally new area of aerospace dynamics. There are no specific missions now being mentioned in connection with this technology program. Even the aerospace plane concept is much too far down the line to be related.

But the technology obviously leads to space ferry applications. The medium L/D ratio area is the one with the largest mission potential. The SV-5 design is volume-oriented as well as being a lifting body. Relatively small base size increases result in large capacity increases.

The Martin heat shield material on PRIME is designed to protect a 300°F aluminum substrate. The firm's Baltimore Div. makes its own glass/plastic honeycomb using a design that permits the honeycomb to be fitted to the complex curvature of the vehicle. The cells are then filled with the silicone elastomeric 3560HF.

The honeycomb is slit at the base edges to allow gases generated during the curing cycle to flow out at parting lines.

The area of lifting re-entry being pursued as a technology program should provide the basis for more definitive programs within the next two to three years.

The question of manned military space operations is not yet settled. DOD experts have reservations about the wisdom of moving into this area on a large scale. Both *MOL* and the lifting re-entry programs are expected to aid in the decision process. This is not to say that there is an absence of controversy. The Air Force instinctively feels manned military space operations are a necessity in this environment and history bears them out.

But the rationale involved in programming funds calls for more than instinct because there does not seem to be any immediate military space threat. The threat is largely hypothetical in the minds of DOD planners. This could change in an instant should events beyond their control provide a new situation. ■

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TOD's Guide to Successful Proposals

UNSOLICITED PROPOSALS in specific areas of research and technology have landed more than $15 million in contracts over the past few months for a host of industrial firms and laboratories.

Maj. Gen. Marvin C. Demler, commander of Air Force Systems Command's Research and Technology Div., told MISSILES AND ROCKETS that such proposals sometimes solved immediate problems in research areas.

The proposals grew out of the Air Force Technical Objective Document (TOD) release program—a series of 36 separate documents covering every area of research and technology deemed necessary for future military capabilities.

The TOD's are guidance documents as well. The identification of Air Force problem areas also helps firms:

—Plan research and development programs;

—Formulate more germane solicited or unsolicited technical proposals;

—Work more easily with other Government agencies and prime contractors.

Very few unsolicited proposals are funded by the Air Force, simply because most of those submitted do not meet specific problem areas or offer any advance in the state of the art.

Any qualified organization in science and industry that is an R&D contractor, or, because of its capabilities, is considered to be a prospective R&D contractor, is eligible to participate.

The limitations are:

—Only those organizations that have a current sustaining capability and have indicated a willingness to perform R&D in areas of interest to the Air Force as outlined in the TOD's may be authorized to receive them. Only those documents that cover technical areas within the ability of the requesting firm or organization will be released by the Air Force.

—Consultants or organizations without R&D capability or those who use part-time employees as the basis for R&D are not eligible.

—Professional societies are not eligible.

—Organizations in financial difficulties are not eligible.

—Organizations whose capabilities are based primarily on consultants hired by them are not eligible.

—Organizations in the process of forming business pools will not be considered until such time as the pool has been established and approved by the Small Business Administration.

Most of the TOD's are classified and security clearances are required. The methods and procedures to be followed, together with complete details on the nature of the TOD process, can be obtained by requesting the information on the TOD release program from Headquarters, Research and Technology Div., Air Force Systems Command, Bolling AFB, Washington, D.C. 20332, ATTN: RTST.

LIST OF TECHNICAL OBJECTIVE DOCUMENTS

DOCUMENT NO. & CLASSIFICATION	TECHNICAL DOMAIN
RTD 67-1 (SECRET)	Advanced Weapons and Applications
RTD 67-2 (SECRET)	Aerospace Environment
RTD 67-3 (UNCLD)	Aerospace Medicine
RTD67-4 (UNCLD)	Aerospace Vehicle Equipment
RTD 67-5 (SECRET)	Avionic Communications
RTD 67-6 (UNCLD)	Bionics, Lasers, and Molecular Electronics
RTD 67-7 (SECRET)	Chemical and Biological Technical Development
RTD 67-8 (SECRET)	Conventional Munitions
RTD 67-11 (SECRET)	Electromagnetic Intelligence
RTD 67-12 (UNCLD)	Electromagnetic Reliability and Compatibility
RTD 67-13 (SECRET)	Electromagnetic Transmission and Reception (above 15 gc)
RTD 67-14 (SECRET)	Electromagnetic Transmission and Reception (below 15 gc)
RTD 67-15 (SECRET)	Electromagnetic Vehicle Environment
RTD 67-16 (SECRET)	Electromagnetic Warfare
RTD 67-17 (UNCLD)	Flight Control
RTD 67-18 (UNCLD)	Flight Mechanics
RTD 67-19 (UNCLD)	Fuels, Lubrication and Aerospace Support Techniques
RTD 67-20 (SECRET)	Ground-Based Surveillance
RTD 67-21 (SECRET)	Ground Communications
RTD 67-22 (UNCLD)	Human Performance
RTD 67-23 (UNCLD)	Information Displays
RTD 67-24 (UNCLD)	Information Processing
RTD 67-25 (UNCLD)	Life Support
RTD 67-26 (UNCLD)	Materials
RTD 67-27 (SECRET)	Navigation, Guidance, and Defense
RTD 67-28 (SECRET)	Photo Materials and Optronics
RTD 67-29 (SECRET)	Position and Motion Sensing Devices
RTD 67-30 (UNCLD)	Power Generation, Electrical and Advanced Propulsion (Non-Chem)
RTD 67-31 (CONF)	Electromagnetic Propagation and Plasma
RTD 67-32 (UNCLD)	Radiobiology
RTD 67-33 (CONF)	Ramjet Propulsion
RTD 67-34 (SECRET)	Reconnaissance
RTD 67-35 (SECRET)	Rocket Propulsion
RTD 67-36 (UNCLD)	Structures
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AFSC STLO (RTSSL), Langley Research Center, Langley Air Force Base, Va. 23365
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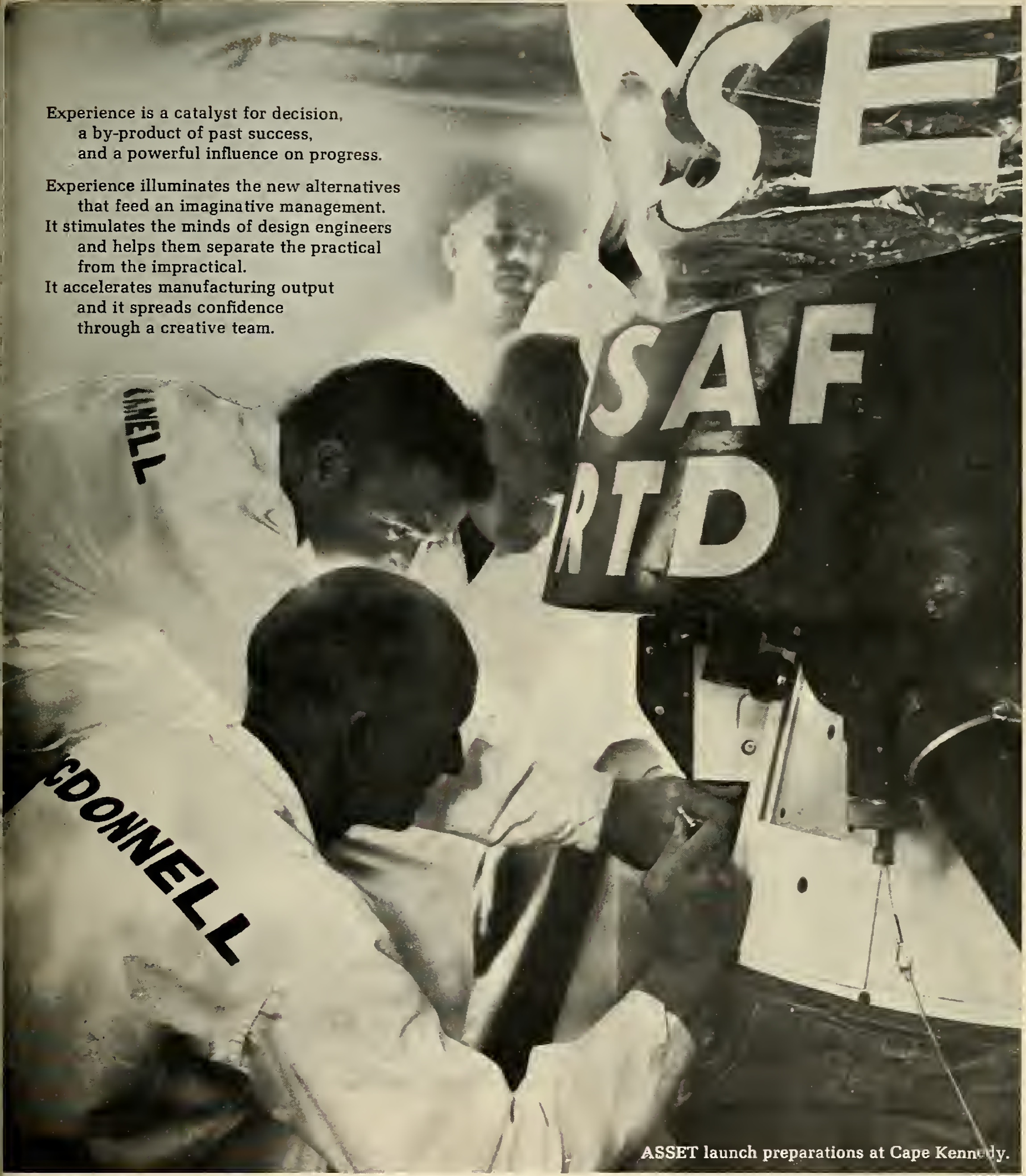
AFSC STLO (RTSSW), Lewis Research Center, 21000 Brookpark Rd., Cleveland, Ohio 44135



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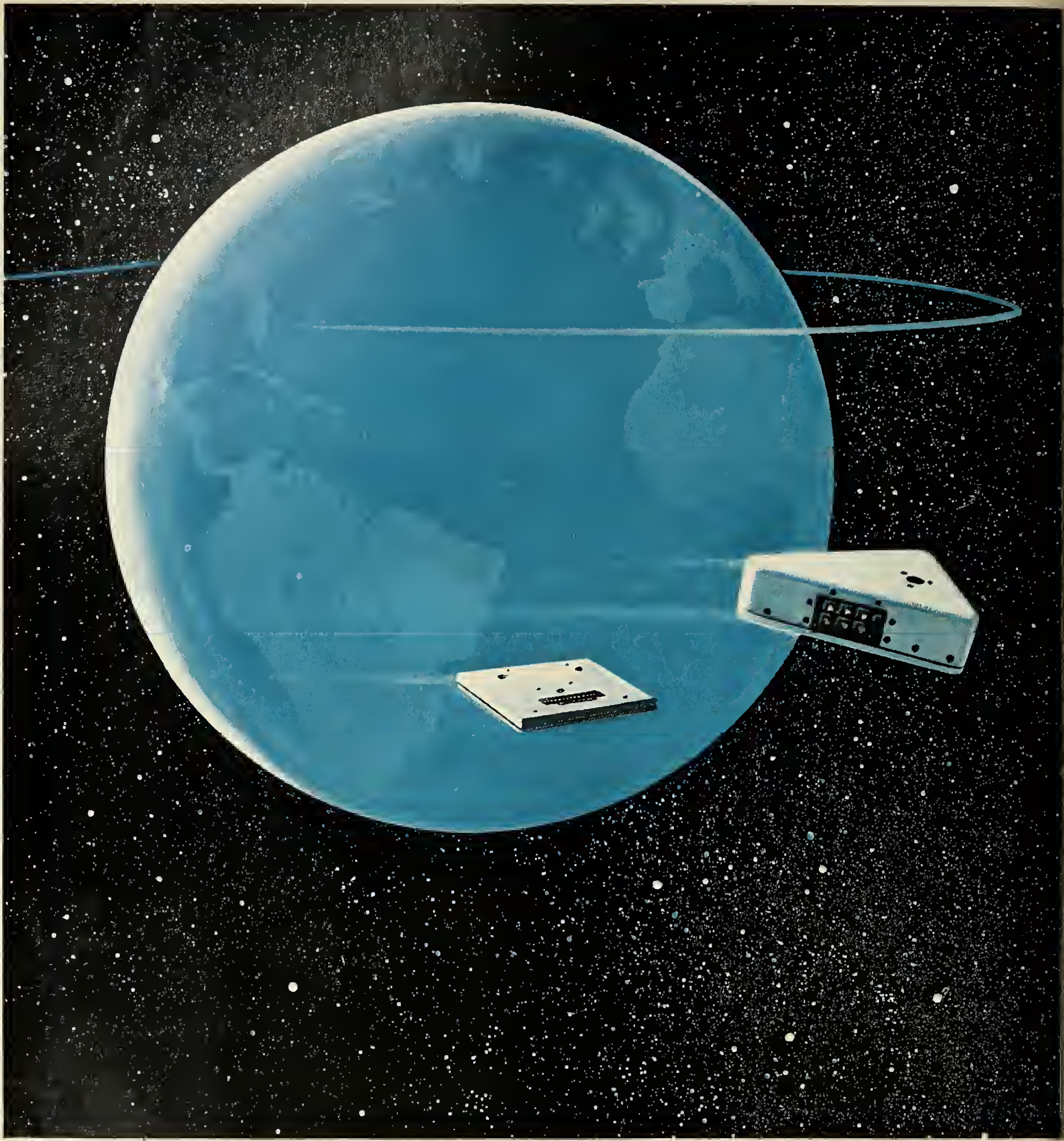

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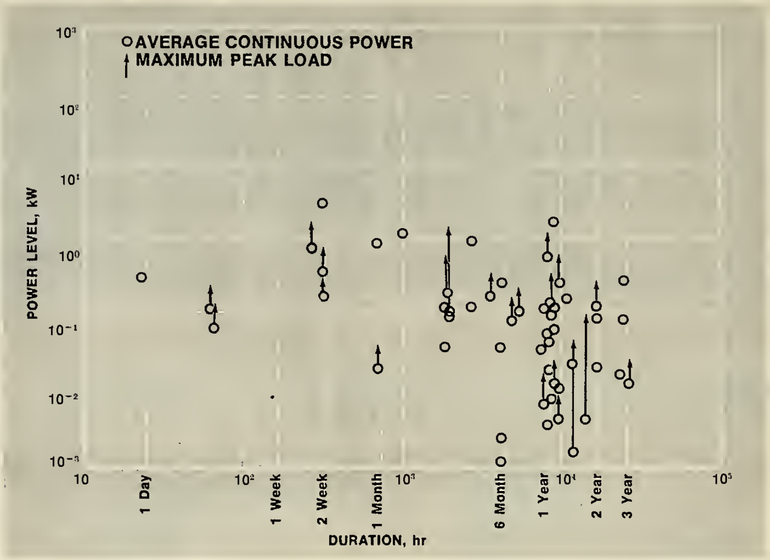


Chart shows potential NASA/DOD mission power requirements for 1965-1970 period. Lockheed and Douglas are analyzing DOD needs in terms of several missions.

Space Power

DOD Seeks More Orderly Development

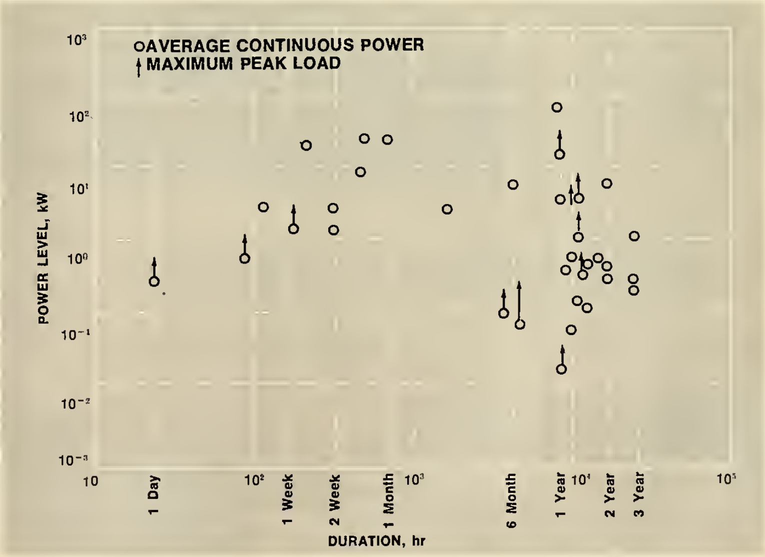
by William S. Beller

WASHINGTON—"Our biggest problem and effort is to get firm requirements for electrical power generation systems for space," said a highly placed space-power officer in the Air Force Systems Command.

This same sentiment was voiced by a policy maker at the Department of Defense level who, noting the current effort to establish missions and thereby electrical power requirements, said, "Almost every space problem we have is overwhelmed by (the need for) power."

A step was taken late last year to set up space power requirements for military space missions when DOD gave Douglas Aircraft Co. and Lockheed Aircraft Corp. separate contracts to analyze power requirements in terms of several space missions. AFSC's Research and Technology Div., which is monitoring the work, is now getting the first interim results from these studies, due in final form in September.

This Douglas and Lockheed work



Potential new NASA/DOD mission power requirements for 1970-1975 time period. Need for power is said to "overwhelm" almost every space problem.

is part of a new DOD space power study aimed at setting up a timetable to develop power subsystems of a type and size adequate for projected military space missions.

The procedure for this study is straightforward: with space missions given, vehicles are determined; vehicles, in turn, are analyzed for on-board equipment and the power needed for them. From this information, researchers can delineate the power subsystems required and suggest when development work should start.

Summing up the possible benefits, an Air Force officer told MISSILES AND ROCKETS that once a schedule for space power is set up, "we can abandon the broad approach of considering all comers and instead move into selection of studies and projects that will lead to recommended systems."

Early requirements—Lacking official requirements for space power, DOD and NASA contributed to a study last year that gives an "optimistic" picture of the total number of space missions that are forthcoming, and the amount of power that will probably be needed for them.

The conclusions are consistent with the more recent finding of the Air Staff that missions requiring more than 10 kilowatts are too far off for hardware development now, and with statements of Dr. John S. Foster, Jr., Director, Defense Research and Engineering, testifying on the Fiscal Year 1967 defense space program before the Senate Committee on Aeronautical and Space Sciences.

The DOD-NASA study is broken down into five time periods. Time Period I goes to 1970, involves programmed, planned or probable space missions, and is "characterized by a predominance of applications for power levels in the range of 0.01 to 0.5 kwe for durations in excess of six months."

Most of these applications are for unmanned satellites, a very few of which may need average power levels of around 1 kwe with possible peaks of up to 7 kwe for short durations.

While not naming specific power requirements, Foster did give a relatively low-power mission as illustrative of military use of space in the near future. "We recognize the increasing utility of deploying downward-looking satellite systems at synchronous altitude," he testified. Going into detail he said that the unmanned synchronous systems will use solar cells where survivability and orientation are favorable and nuclear thermoelectric generators in other cases. Rechargeable batteries would supply peak loads.

Although solar cells are a standard for space power, they do suffer in comparison with other possible systems in terms of cost and radiation resistance. For this reason, DOD will continue to support development of reliable and lighter weight solar cell systems and batteries, according to Foster.

The DOD-NASA study referred to earlier points out that the cost of present solar cells for most current missions are about \$250/watt but can run as high as \$800/watt of generating capacity in the heart of the Van Allen belt. "The cost of solar cells is expected to drop to \$75 to \$100/watt by 1975," the study suggests, "if a large market is established."

From 1970-75—Military spacecraft operating in the first half of the 1970's, or Time Period II, will probably have to meet requirements similar to those of highly sophisticated modern military aircraft, and several more put in by the mechanics of spaceflight. Thus, the power generation systems for these and later military spacecraft will be influenced by the need to minimize waste heat radiation, to keep the radar cross-section small, to achieve low-orbital decay, and possibly to allow for spacecraft maneuvering. Moreover, a need for artificial gravity on manned

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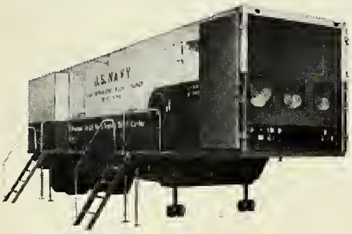
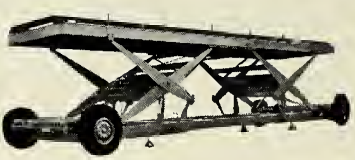
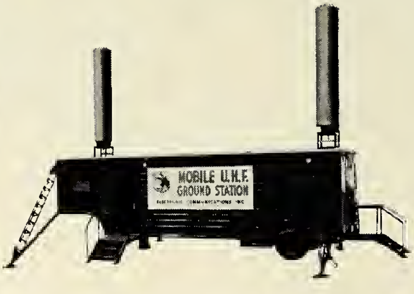


Van with expandable sides and roof.


Elevator platform trailer.

Numerous openings require special design to retain structural integrity.



Air-borne electronics van with sway braces.

NASA
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Full trailers to transport nose cone of Nimbus missiles.

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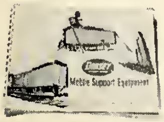

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PROGRAMMERS, SCIENTISTS ENGINEERS, MATHEMATICIANS

No matter which way you turn (East or West), if you want to go places (Florida or California), we've got the opportunities to help you arrive.

Openings at WESTERN TEST RANGE

Positions in direct support of the Calibration and Performance Evaluation of all instrumentation at the Western Test Range are immediately available with Federal Electric Corporation. Our mission includes tasks engendering problems of a complexity sufficient to challenge the most advanced knowledge in the state-of-the-art. High level positions are currently available in the following disciplines.

AEROSPACE SPECIALIST

Requires PhD or MS in Physics or Engineering. Experience should be directly related to the area of space flight mechanics including orbital mechanics, equations of motion, drag effects, missile guidance, impact prediction and the reduction of orbital data from metric systems.

MATHEMATICAL SPECIALIST

Requires PhD or MS in Mathematics, Physics or Engineering. Experience should include applied work in the techniques of smoothing, prediction, differentiation and integration of data obtained from metric instruments. The determination of orbital elements and generation of math models for impact prediction, guidance and control, re-entry drag, earth oblateness and the statistical analysis of data.

SYSTEMS ANALYST

Requires MS in Engineering, Math or Physics. Background must include experience in real time scientific and systems applications associated with range launch support and implementation of data reduction systems including real time missile tracking, data systems software and hardware evalution analysis and/or design. Requires sufficient broad knowledge to provide high level engineering support to the range data complex.

For preceding positions forward your resume to Mr. I. L. White, Federal Electric Corporation, Box 446, Lompoc, California.

Openings at JOHN F. KENNEDY SPACE CENTER

These openings are for real-time, data reduction applications associated with range operations in support of the Gemini and Apollo space programs at the John F. Kennedy Space Center in Florida—where Federal Electric Corporation is engaged in implementing KSC's central scientific computers to the task of data recording, reduction, transmission and real time display of thousands of measurements telemetered from the vehicle, spacecraft and ground support equipment.

SCIENTIFIC AND SYSTEMS PROGRAMMERS

Openings at all levels for real time data reduction and software techniques and development. Duties entail implementing KSC's GE 635 multi-programmed/multi-processor computers to the task of real time and post test telemetry reduction, data transmission, real time display, software techniques, and complier/assembler development.

SUPERVISORY ENGINEER (PCM Telemetry)

BSEE with 5-8 years' telemetry ground station experience of which at least two years of PCM Telemetry, Digital Data Transmission, or computer related hardware experience is required. The successful applicant will have experience in the technical direction, management, and systems engineering of a real time Telemetry Ground Station or data transmission facility. Primary responsibilities will be general supervision of the installation, operation and maintenance of designated technical facilities.

ELECTRONIC ENGINEERS (PCM Telemetry, Calibration, Instrumentation)

Applicants should have a BSEE degree plus a minimum of 5 years experience in the design, development, operation or analysis of complex electrical or electronic instrumentation systems. Responsibilities will include general supervision and instruction, development of new procedures and techniques, and overall documentation and reporting of the activities of electrical and electronic instrumentation facilities.

For preceding positions forward your resume to Mr. H. B. Arnold, Federal Electric Corporation, 8660 Astronaut Blvd., Cape Canaveral, Florida.

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flights might introduce constraints, particularly where the power system might need accurate orientation to the Sun or Earth.

For military purposes, "power subsystems having large area components such as large solar array panels, mirror collectors, and/or radiators are not desirable for low-altitude applications," according to the DOD-NASA study.

The power requirements for this period, both military and civilian, will probably be for 1-10 kwe for many weeks. This is brought about by the probable increase in major space missions but a decrease in total number of missions, together with a larger number of manned flights.

The Air Force, as well as other agencies, sees the fuel cell playing an extremely important part in this period, chiefly because of the unit's reliability and high power output with great efficiency. "Its main attraction," said an Air Force spokeman, "is its ability to convert 60-70% of the available energy to electrical power." Right now, the fuel cell has about a two-week life. "By 1975, we hope to get the life up to 45 to 60 days," he said.

Yet there are problems in developing larger models for the 1970's. In particular, there is the difficulty of scaling from small to large cells and from single cell to multicell systems. Interactions between cells result in cell failures sometimes considerably different from those experienced in single cells.

For manned systems at any altitude, the fuel cell will be used in place of or together with batteries. A nuclear system would first have to pass rigid testing because of its radiation hazards to men and equipment.

"We are exploring more efficient and longer-lived fuel cell concepts, including the use of hybrid fuel cell and nuclear thermoelectric applications," said Foster. "We will pursue advanced fuel cell technology and, together with AEC, the advanced nuclear thermoelectric technology to apply to these system concepts in the early 1970's."

The hybrid fuel cell, which an Air Force scientist says is the "next thing in auxiliary space power coming along," is a combination of a solar cell and fuel cell. The fuel cell would carry power for the peak loads while the solar cell subsystem would take care of the power requirements on a continuing, long-time basis. Thus in the hybrid system, the fuel cell would be replacing the battery, and could possibly be used up to six months or more. "At least, this is our initial goal," he said.

From 1975-80—Power levels for the late 1970's and beyond will be high. Foster expects them to hit 10 kwe and higher. The DOD-NASA study estimates 5-kwe average with 20-kwe peaks. The Air Staff, as indicated earlier, does not think it worthwhile to develop anything bigger than 10 kwe.

The power requirements may be pushed even higher than these estimates if electric propulsion and electronic counter measures become part of the missions of military spacecraft.

Reliability will be extremely important, especially for manned operations with spacecraft systems in use in orbit possibly a year or more. The Air Force believes it probably will have to go to some type of dynamic system to get the high power, and "we'll have to lick the reliability problem to do it," a spokesman said.

For turbomachinery power generation, DOD is looking into both the organic and liquid-metal Rankine cycles, and the Brayton cycle. These are coordinated projects with the AEC and NASA. At the same time, DOD is trying to find ways to generate large amounts of power without turbomachinery, according to Foster. "These include using very large solar cell devices and thermionic diodes coupled to high-temperature heat sources," he said.

A system involving a nuclear reactor, though, is least likely for manned orbital flight unless the reactor is used as part of a gravity gradient system, is held off from the crew by a large boom and is adequately shielded.

For relatively low power in this period, under about a kilowatt, the Air Force believes that radioisotope themoelectric units "will proliferate." A number of firms are working in this field, including Atomics International, General Electric, Martin Co., 3M Co., and Westinghouse Electric. Moreover, a radioisotope might even be used to power a Brayton or Rankine cycle.

For such radioisotope cycles, polonium-210, an alpha emitter that is easily shielded, might be used for manned flights. Similarly, plutonium-238, though not plentiful now, might be in better supply in the next decade and could also be used for manned flight. On the other hand, strontium-90 is so radioactive its use would probably be restricted to unmanned vehicles.

For the last time period, from 1980 onward, all projections are speculation. This is possibly the period in which a SNAP-50/SPUR unit of 300 kwe to one megawatt would be useful. But to try to build such a unit now would be wasteful of technology, said a DOD official, and it would undoubtedly be an obsolete machine when it came time to use it. Nevertheless, the concepts and systems that will be needed to furnish space power in the late twentieth century take form in the 1960's and 1970's. For this reason, DOD will consider ideas for future applications. ■

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PROGRAM MANAGERS—Technical degree required. Technically direct and administer programs in the area of flight and aerospace simulation. Previous experience in project management desired.

SYSTEMS ENGINEERS—Perform analysis and system design of aerospace/aircraft systems in the areas of navigation, communications and instrumentation, radio, electronics, pneumatic, hydraulic, pressurization, and temperature control. Synthesize simulation to be programmed on large-scale digital computers.

TACTICS DESIGN ENGINEERS—Design simulated complex electronic warfare systems utilizing analog and/or digital computing techniques. Must be experienced in the design and/or test of radar. IR, fire control, ECM, ASW, Bomb/Nav. systems and CRT displays. Senior level must be able to reduce systems and situations to math models.

CIRCUIT DEVELOPMENT ENGINEERS — All levels required to work on circuit design and development for instrument servos, video systems, analog computation equipment, and general control systems. Work will involve special-purpose designs to meet systems requirements not satisfied by existing equipment. Thorough background in solid-state circuitry is essential.

PHOTOGRAMMETRISTS — Senior and Intermediate levels to work in systems development of complex and highly automated film data reduction equipment. Much of this equipment involves state-of-the-art development in such diverse areas as imagery correlation, imagery recognition, code reading, automated alignment, and allied areas. Experience in specifying or development of this type of equipment is desirable.

RELIABILITY ENGINEERS — Must perform reliability/maintainability predictions and evaluations. Conduct failure evaluation system analysis. Knowledge of circuit, computer or optic design helpful.

INDUSTRIAL ENGINEERS—Bidding, cost and management proposal preparation, management controls, budgets, etc. Determine most economical assembly sequences, designs and/or orders tooling to facilitate assembly of complex electro-mechanical products. Experience in time standards, work measurement and motion and time study techniques.

SALES ENGINEERS—BS degree or equivalent in sciences or traffic control. Pilot training or military electronics experience desirable but not mandatory. Assignments are in the areas of aircraft or aerospace flight simulation equipment, precision electro-mechanical devices, optical scanning devices, video displays and transportation systems.

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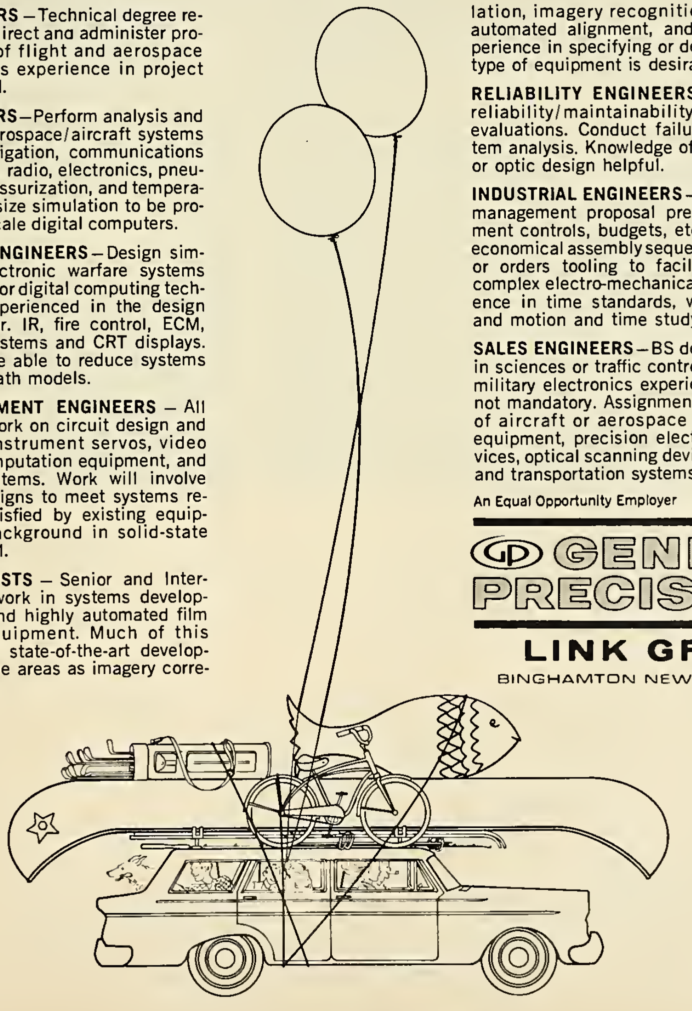

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  Armament Systems Installation
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Propulsion Design
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GENERAL DYNAMICS
Fort Worth Division

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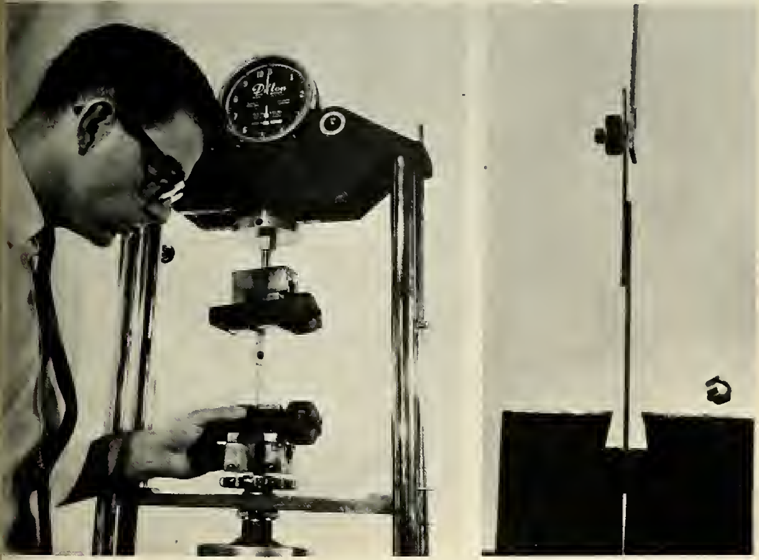
Products and Processes



New Product of the Week:

Anaerobic Adhesives

A family of single-part, anaerobic adhesives are available from Loctite Corp.

The adhesives are equal to the strengths of current epoxies but harden in the absence of air. They have an almost unlimited pot life, the firm says, cure quickly at room temperature or even faster with mild heat, and require no mixing. The materials have high tensile strength as well as shear strength. They are particularly suitable for metal-working production assembly lines.

The potential of the family is shown above where an overlapped aluminum strip specimen fails in the bolted joint rather than the Loctite 310 bond area. The five structural adhesives in the new line are Hot Strength Adhesive 306, High Tensile Adhesive 307, Impact Resistant Adhesive 308, Flexible Adhesive 309, and General Industrial Adhesive 310.

Circle No. 151 on Subscriber Service Card

Digital Computer System

A digital computer system intended for integrated data acquisition system and industrial applications has been announced by ASI Computer Div. of Electro-Mechanical Research, Inc.

The ADVANCE 6130 system is a total monolithic integrated circuit machine. Multiple bus organization is featured, providing for simultaneous communication and control of multiple central processors, multiple I/O channels and multiple memory modules. It is claimed to be the only small scale computer to have third-generation systems organization.

The 16-bit data word machine has a repertoire of over 100 instructions, accomplished with single- and double-word instruction formats. Memory modules of various sizes and speeds, and up to six fully buffered I/O channels, including word/byte channels and multiplex channels, are available.

Circle No. 152 on Subscriber Service Card

Electronic Counter

Hewlett-Packard is marketing a reversible electronic counter that incorporates six counting modes.

Model 5280A reversible electronic counter counts at rates up to 2MHz, reverses in 250 μsecs, and has a reverse counting rate of 1 MHz. The unit will count either of two input channels, A or B, or count A upward or downward, depending on the polarity chosen for B, at a 2-MHz rate. It will count A + B, A — B, or count up or down, de-

collage

More Motorola Melange, continued from page 54

Meanwhile, up in the ivory tower...

speaking of polysyllables & polyfrequency

Our Chicago Center's Communications R & D Lab is all atwitter over something they call digital frequency synthesis. It has to do with an I/E approach in military radio sets that permits quick and reliable multi-channel operation. They've written about it in our new Engineering Bulletin, and we'll send you a copy if you can take words such as "Polyfrequency...Neoteric approach to frequency synthesis"... and like that.

A personal note to all native ☆☆ Americans ☆☆

(except Navajos who are already hip)

Our microwave people at the Chicago Center sold a gigantic microwave communications system to the Navajo Indian Reservation. It will link parts of Utah, Colorado, Arizona and New Mexico, providing party and private-line telephone circuits for Navajo police, utilities, rangers, construction crews and so forth. Whether or not you're a member of an Indian nation, write for our problem-solving microwave systems diagrams and folders... keep up with the Navajo!

Holy Trademarks!

They took that, too!

Look at our Motorola symbol down there. Those bat guys even stole that for their TV show. Where will it all end? (It began on the first page of this 3-page saga.)

GREAT INFORMATIVES! Write to the appropriate center — address below — for information about anything described on these pages!

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Military Electronics Division
CHICAGO CENTER
1450 N. Cicero Ave., Dept. 4, Chicago, Illinois
WESTERN CENTER
8201 E. McDowell Rd., Dept. 4, Scottsdale, Arizona

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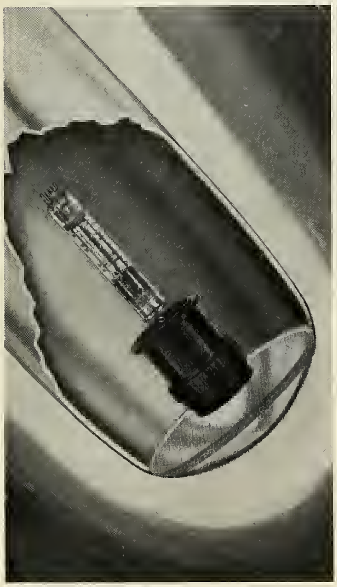
GEC tv "sight system" spots the target



The three principal components of any television weapon guidance system — the window, the lens and the vidicon — are shown above. Designed and manufactured by GEC, they illustrate our total electro-optical capability.

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pending on the relative phase of A and B, at rates up to 1 MHz.

The instrument is capable of operating in a temperature range from 0° to 50°C. Inputs present 1 megohm to the external circuit. Sensitivity is 100 mv and either a-c or d-c coupling may be selected.

Circle No. 153 on Subscriber Service Card

Metal Crystals

Advanced Materials Div. of Materials Research Corp. is marketing single crystals of ultra-high purity metals, such as aluminum, copper, gold, silver, and other low-melting-point metals and their alloys.

The crystals are produced by electron beam processes. Surfaces of specified crystallographic orientations for use in corrosion, low-energy electron diffraction and other surface phenomenon studies, are available to within one degree of specified orientation.

Sizes up to 1-in.-diameter and 6-in.-length are available.

Circle No. 154 on Subscriber Service Card

Semiconductor Transducer

A semiconductor pressure transducer designed to measure low pressures and deliver high unamplified output under conditions of extreme vibration and acceleration has been developed by Micro-Systems, Inc.

Model 1028 uses four semiconductor strain gages bonded to a miniature cantilever beam, which is driven by a push rod welded to a thin, stretched, pressure-sensing diaphragm. This system results in natural frequency of no less than 4,000 cps in the 2 psi range, and response of 1 ms maximum to achieve 63% rise time. Maximum vibration and acceleration sensitivity is 0.02% FS/g.

The instrument operates at temperatures from -65° to 300°F in deep-space vacuum conditions and is temperature-compensated from 0° to 250°F. Performance is possible under accelerations up to 1,000 g. With up to 30v d-c excitation, the unit produces a minimum output of 300 mv with a combined accuracy of ±0.5% FS.

Circle No. 155 on Subscriber Service Card

Digital Plotter

A digital incremental plotter designed to self program up to 100 or more steps from a single input command has been announced by Benson-Lehner Corp.

The B-L delta plotting system consists of two subsystems, a control unit and a digital incremental plotter. The delta control logic enables the associated plotter to move more than one step per command, so that up to 100 steps in X and/or Y can be generated from one punch card instruction. One command from computer or tape will produce up to 127 incremental plotting steps.

As a separate subsystem, the delta control unit can be used with existing plotters to multiplex computer output, or to provide an off-line system with punch card input.

Circle No. 156 on Subscriber Service Card

Laser System

A laser system claimed to have nearly three times the brightness of any other commercially available laser has been announced by Korad Corp.

The K-1500 system has a maximum brightness of more than 2.5 x 10^{14} watts per square centimeter per steradian, and is capable of 400 to 500 shots at maximum output. Oscillating fields of 300 million volts per centimeter, and magnetic fields of one million gauss, can be generated by focusing the laser on a 30-micron spot.

The instrument is an oscillator-amplifier system with a peak power of greater than one gigawatt and emission at 6,943 Angstroms. Beam divergence is less than two milliradians, full angle at half power. Pulse width is approximately 12 μsecs.

Circle No. 157 on Subscriber Service Cord

Self-Tuning Filter

Interstate Electronics Corp. has announced an all-solid-state self-tuning band-pass filter capable of continuously tracking input signals slewing at rates over 600 KHz per second throughout the 100-Hz to 12-KHz range.

Model PL 416 captures a signal at -24 db SNR at its narrowest (5 Hz) bandwidth and at -7 db SNR at its broadest (250 Hz). The unit delivers three frequency multiplied outputs, all coherent with the input signal. Integrated circuits are used in all high-speed digital frequency dividers. A special memory circuit retains the last known frequency during momentary signal loss.

The phase-lock instrument features accurate voltage analog, remote tuning, internal calibration oscillator, 2% full-scale frequency meter and visual correlation indicators. Optional automatic sweep, pilot acquisition and selected tracking bandwidths are available.

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Names in the News

HAMILTON

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LAWRENCE

PERZLEY

Anthony R. Hamilton: Appointed senior vice president of Avnet, Inc.'s Electronics Div. He will continue in his present capacity as president of Hamilton Electrosales.

Harry W. Kohl: Named a vice president of the Lockheed Missiles & Space Co. He will head the company's electronics organization. He moves to the new post from his position as director of operations services.

Dr. Robert E. Davis: Appointed manager of Aerojet-General Corp.'s Fleet Ballistic Missile Div. of Solid Rocket Operations. Before his new assignment, he has served as associate manager of the division and has been associated with the *Polaris* program since the development of the *Polaris A1*.

Thomas H. Quayle: Appointed vice president and manager of Northrop Corp.'s Nortronics Div. He has been with the corporation since 1939. He previously was assistant to the vice president and general manager of Nortronics.

Roland B. Lawrence: Named senior vice president of ne product development of the Deutsch Co., Electronic Component Div. He has been with the company since 1959.

William Perzley: Named president of Consolidated Avionic a division of Condec Corp. He joined the corporation in 1959 a director of research. He was named vice president and gener manager in 1962.

Jack I. Hamilton: Named a vice president of Cleveland Pneu matic Tool Co., a subsidiary of Pneumo Dynamics Corp. He con tinues as director of marketing with responsibility for the com pany's product lines in all areas—missile/space, ordnance an marine.

E. Clinton Towl: Elected chairman of the board of director and chief executive officer of Grumman Aircraft Engineerin Corp. **Llewellyn J. Evans** will succeed him as president of th organization.

J. Paul Jones: Elected a corporate vice president of Motorol Inc., and also named assistant general manager of the Militar Electronics Div. He will continue in his capacity as manage of the Western Center.

M. Scott Carpenter: Elected an honorary fellow of the Insti tute of Environmental Sciences. The award is for his outstandin personal contribution in environmental sciences, for participatio in flight testing, space environment testing and underwater tes programs.

William N. Auld: Elected vice president in charge of manu facturing for Deltron, Inc. He joined the company in 1964.

Dr. Philipp H. Klein: Joined NASA's Electronics Researc Center as physicist in the component technology laboratory. H was formerly technical staff member at the Sperry Ran Research Center.

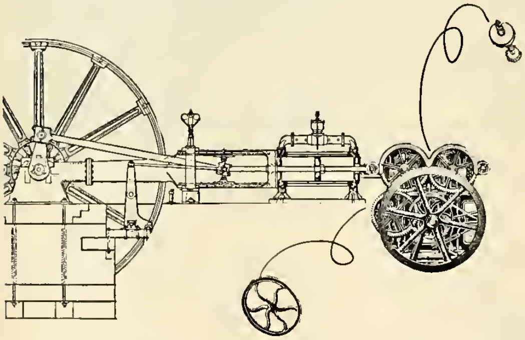
Dr. Alexis G. Pincus: Joined the staff of IIT Research Insti tute as scientific advisor in the Ceramics Research Div. He was visiting lecturer and research engineer at the University o California at Berkeley from 1962 to 1963.

Alexander P. Kundrotas: Appointed vice president, aerospace of Hallicrafters Co.'s military division. He joined the compan in 1959 as an assistant group leader and since that time ha served in several technical positions.

David K. Elwell: Appointed eastern regional vice presiden for Sylvania Electric Products, Inc. He will be responsible fo coordinating the sales activities of the company's nine operatin divisions in 19 states.

Morgan H. Cooper: Elected vice president of corporate de velopment of Oak Electro/Netics Corp. **John Cassato** was name vice president of corporate relations. Both men joined the firn in 1960.

Stuart L. Dance: Appointed vice president of marketing fo Melpar, Inc., a subsidiary of Westinghouse Air Brake Co. H will be responsible for administration of all the marketing func tion, including field and local area sales.



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When and Where

MAY

econd International Oceanographic Congress, Moscow, Russia, May 30-June 9.

JUNE

0th Annual Technical Conference & Exhibit, sponsored by the American Society for Quality Control, Statler Hilton Hotel, New York City, June 1-3.

ew England Regional Metalworking Conference and Exposition, sponsored by the American Society for Metal, War Memorial Auditorium, Boston, June 2-4.

econd International Aircraft, Airport Equipment and Space Exhibition, sponsored by the Italian Federationo/Aerospace Industries, Turin, Italy, June 4-12.

ubrication Symposium and Symposium on Friction and Lubrication in Metal Processing, sponsored by the American Society of Mechanical Engineers, Royal Orleans Hotel, New Orleans, June 5-9.

Design & Construction of Large Steerable Aerials for Satellite Communication, Radio Astronomy & Radar, sponsored by the Institute of Electrical and Electronics Engineers, Savoy Place, London, England, June 6-8.

11th National Plastic Exposition, sponsored by the Society of the Plastic Industry, Inc., New York Coliseum, New York City, June 6-10.

20th Annual Convention of the Armed Forces Communications and Electronics Association, Sheraton-Park Hotel, Washington, D.C., June 7-9.

Society of Applied Spectroscopy, National Meeting, Sheraton-Chicago, Chicago, June 12-17.

Second Cryogenic Exposition, sponsored by the Cryogenic Society of America, Inc., University of Colorado, Boulder, Colo., June 13-15.

Filmed Data & Computers Meeting, sponsored by the Society of Photo-Optical Instrumentation Engineers, U.S. Air Force Electronic Systems Div., Sheraton Boston Hotel, Boston, June 13-14.

14th Annual Technical Writers' Institute, Rensselaer Polytechnic Institute, Troy, N.Y., June 13-17.

Second Propulsion Joint Specialist Conference, sponsored by the American Institute of Aeronautics and Astronautics, U.S. Air Force Academy, Colorado Springs, Colo., June 13-17.

American Association for Advancement of Science, Seattle, June 13-18.

AGARD Lecture Series on The Application of Microelectronics to Aerospace Equipment, Nice, France, June 13-14, Delft, Netherlands, June 16-17.

16th Annual Earth Science Orientation Conference, sponsored by Geophysical Service, Inc., Southern Methodist University, Dallas, Texas, June 14-17.

Advanced Launch Vehicles & Propulsion Systems Conference, sponsored by the Society of Auto Engineers, Sheraton Motor Inn, Huntsville, Ala., June 14-16.

Defense/Space Marketing Conference, sponsored by the American Marketing Association, Palmer House, Chicago, June 13-15.

Communications Conference, sponsored by the Institute of Electrical and Electronics Engineers, Sheraton Hotel, Philadelphia, June 15-17.

International Chemical and Petroleum Engineering Exhibition, Olympia, London, England, June 15-24.

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Space Is a Place

THE NATION'S space-based military programs are in much sounder shape today than many realize. This is so because a large portion, classified, remain hidden from view. It is precisely in this unseen area that the largest strides have been made.

The reconnaissance and early-warning programs, with clearly definable objectives, easily match Dept. of Defense operational requirements and cost effectiveness standards. As a result, funding has been adequate. Money is not the only tool needed to solve a problem but it frequently proves useful.

The operational reconnaissance satellites are returning impressive results. Sensor problems in what used to be the *MIDAS* early warning program have been solved and this project, now progressing in Program 266, is leading to a system of synchronous satellites equipped not only with infrared sensors but also with a variety of electronic devices.

Success in surveillance also is making the follow-on options obvious even to the most doubtful. If you can detect something, you can track it—not only in its terminal phase but also in its boost and coast phases. Once you succeed in that, you can begin to think about interception in something other than the terminal phase. Anyone who has listened to U.S. astronauts describe how clearly they can see ballistic missile launches with the naked eye can, with imagination, carry this reasoning to some logical conclusions.

All these things have helped firm up the Air Force sales pitch to the hard-headed DOD hierarchy. Some years ago, the Navy engaged in a fight for the strategic bomber role to the neglect of an anti-submarine warfare problem of such dimensions it could have brought double the appropriations for ships and aircraft if successfully pursued. If the Air Force does not fall into a similar trap, the market for defensive space-based military systems can be expected to increase substantially.

This growth also raises the question of defending these systems. While the Soviets have as yet shown no intentions of knocking down U.S. satellites or space vehicles, it is true that space-based systems are particularly vulnerable to interception. We may yet see the day of laser beams zapping across space to knock out intercepting missiles.

At the same time, DOD has shown recognition of the fact that what we are capable of doing in regard to orbital weapon systems of either an offensive or defensive nature, the Soviets are equally capable of doing. Therefore, development of ground-based satellite intercept systems is continuing at a low level. Space-based inspection and interception systems eventually may provide a better answer to this threat.

After unnecessary years of delay, an operational military communications satellite system is nearing reality.

Superimposed on all this unmanned activity is the *Manned Orbiting Laboratory* project. Much-delayed and over-studied, *MOL* remains nonetheless an open-end program with a potential that perhaps even the most vocal advocates of a manned military space program cannot see at this time. *MOL* has some operational objectives now but its greatest value still may lie in the area of serendipity—the discovery of that which was unknown when the journey began.

Funding of *MOL* no longer depends on such esoteric possibilities, however. Success of the unmanned programs has demonstrated what might be done from an orbiting or synchronous manned space station. The Secretary of Defense therefore seems to have committed himself to the project. The test of that commitment will come in drawing up the Fiscal 1968 budget, where the need to step up *MOL* to a $400-500 million level runs head-on into the financial strain of the Vietnam war.

SPACE, it has been noted, is a place, not a mission. By forcing the Air Force to concentrate on the missions, the Secretary of Defense has brought forth a much clearer picture of the step-by-step development that can be expected in the military use of space in the years ahead. It can be argued that more definite action and less active definition would have moved Air Force space activities ahead at a much faster pace. Be that as it may, the need for military operations in space is more apparent today than it was.

These operations should not be regarded as part of a national space program. They will take place because of a military need for a surveillance system, or a defense against ballistic missiles, or a requirement for global command and control. The need is part of a military program; not a space program. Duplicating development certainly should be avoided but it must be recognized that the military is going into space, not because it is there, but because of what it can do from there better than from anywhere else.

Once that is acknowledged, there should be no conflict between the Air Force and the National Aeronautics and Space Administration in the definition of objectives.

But it also means that DOD, in order to continually push forward the state of the art, must be willing to strongly support and adequately fund the development of advanced military technology, even when no immediate connection with operational requirements is apparent. The refusal to fund *MOL* launches until some operational objectives surfaced makes the lack of strong DOD support for pure research and development objectives quite apparent. Today, that remains the weak spot of the military approach to space activities.

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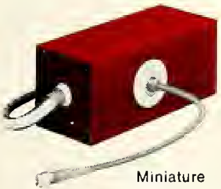

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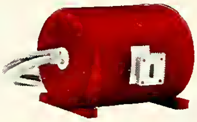

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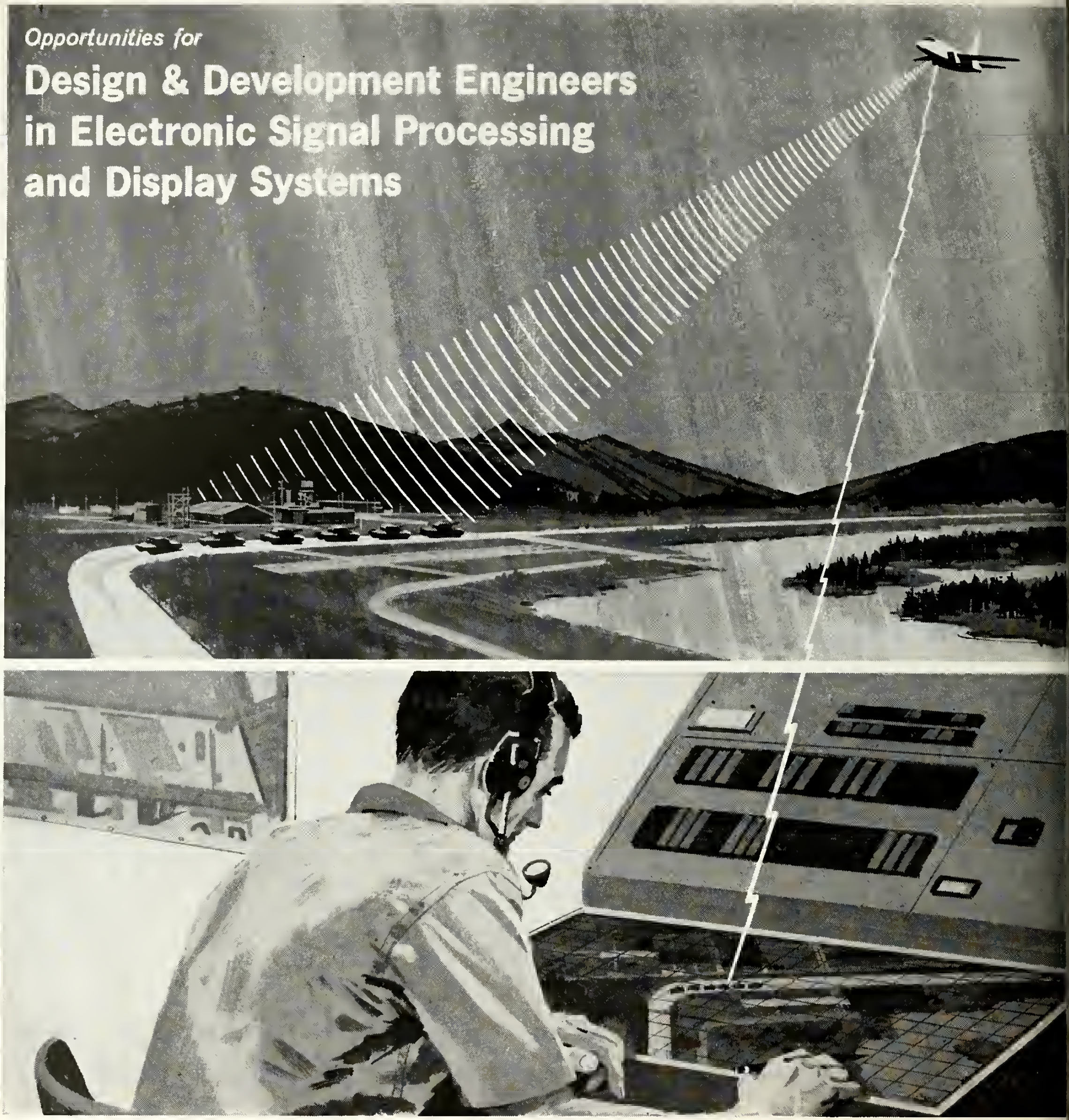

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Volume 18, Number 23 June 6, 1966

technology week

INCLUDING MISSILES AND ROCKETS

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THE COVER

Anechoic chamber at IBM Electronics Systems Center, Owego, N.Y., is first to use double transmitter design. Built for IBM by B. F. Goodrich, the facility is used to evaluate methods of sorting and identifying multiple RF signals, such as those emitted by enemy radars. Absorbers lining the chamber minimize RF reflections.

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Memo from the Publisher

TEN YEARS AGO, American Aviation Publications started a new publication for the missile and space industries. Its purpose was to keep you, the reader, abreast of the latest and most important happenings in the scientific, engineering, and management areas of this most dynamic industry.

Today, as indicated by our symbolic double cover, marks the first issue of M/R under a new name—TECHNOLOGY WEEK. The reasons for this name change are numerous, but the primary reason revolves around you, the reader.

Two years ago, M/R began its investment in this advanced technology we talk so much about editorially. We installed our first computer. Many of you have received our subscriber questionnaire, which asks many questions about you, your job, your areas of technical responsibility in your job, your experience, your salary range, and many other things that we wanted to know about you. Our thanks to those of you who have answered this questionnaire—and those who will do so in the future.

Most of what you told us we felt we knew, but there were some startling things that made us push harder for more and better information. We wanted to know more about you so that our editors could serve you better.

For example: two years ago, M/R published its first special report on anti-submarine warfare (ASW) and oceanology. Last year our Oceanology Report (Sept. 6) won the coveted Jesse H. Neal Award for the best feature article or series of articles in magazines with more than 40,000 circulation. Our computer tells us that oceanology is growing in importance in your lives. We now know that more than 10,000 of you are actively engaged in your jobs within this category. This is almost twice the figure of a year ago.

The indications are that you, our readers, are doing more different things than ever before. You are being called on to apply advanced technology in many new fields: oceanology, as we have mentioned; the supersonic transport (SST); a world-wide communications network; the ground war in Vietnam; metals and advanced materials; fluidics; electronics—and on and on.

Governor Edmund G. Brown of California has issued four separate contracts to missile/space firms to apply their technology to non-defense problems. The Federal Government also is moving into this area—with money and with contracts.

We want to follow you into all these projects, to keep you informed about the advancement of the aerospace technologies as they move into all these new fields.

The name MISSILES AND ROCKETS obviously is the wrong name for such a publication. So we have changed it. From now on you'll be reading TECHNOLOGY WEEK, a publication devoted to the applications of aerospace technology from the ocean floor to outer space.

You will still find Bill Coughlin's editorials, The Countdown, the Technical Countdown, Industry Week, and all the other regular features you have come to count on. In addition, TECHNOLOGY WEEK will keep you on top of the technology in the broad scope of M/R editors.

We have armed ourselves with a computerized research program in which we have invested more than a quarter of a million dollars, with more information about our market, our technologies, and—most important—more information about you and how we can serve you better.

For our new name we have selected from our subtitle those elements—TECHNOLOGY WEEK—that best describe the reading and job interests of you, the reader. We hope you like it.

AC Boughton
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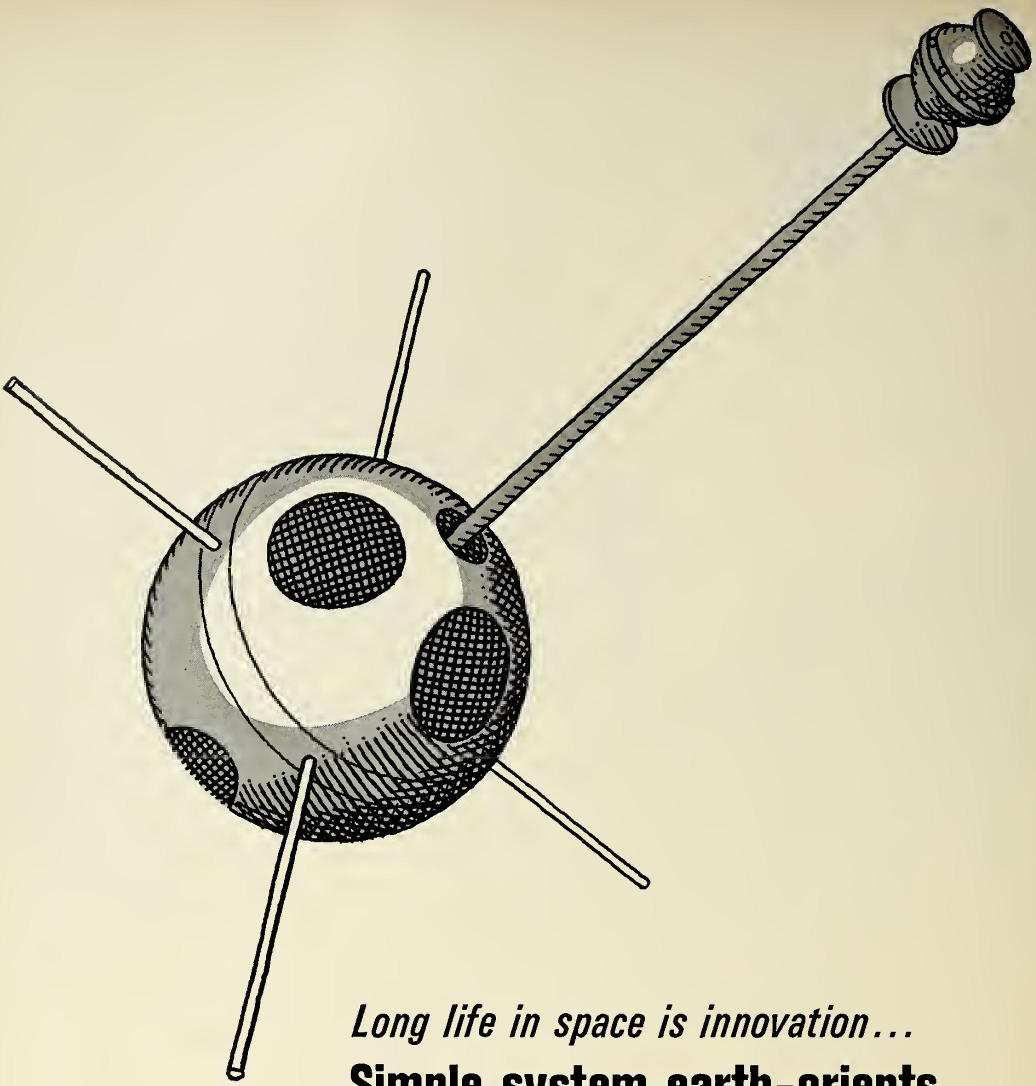

Long life in space is innovation...

Simple system earth-orients satellite for two years

The development of gravity gradient stabilization systems—unique in their mechanical operation and extreme simplicity—is the result of a major G-E program to attain long-life space systems. The success of this design innovation was proven when a system with only 15 parts successfully stabilized an operational satellite and met all design objectives in its initial launch. It is still operating effectively in orbit two years later. In all functions, at all levels, achieving long life in space is the ultimate goal of the . . .

MISSILE AND SPACE DIVISION

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The Countdown

WASHINGTON

Head-on Mode Sought for Chaparral

Army is funding studies that would give its new *Chaparral* forward-area air-defense missile a head-on attack capability against incoming aircraft. The system now uses basic *Sidewinder* infrared heat-seeking guidance which is designed for rear-hemisphere attack. Also under study is field lay-out of the 32 fire units in each *Chaparral* battalion so that any target which is head-on to one unit will be side-view to another, enhancing hit capability with the heat seeker.

DDR&E Okays Dual Interim ARM Development

Pentagon insiders say the Directorate of Defense Research and Engineering has approved parallel development of the AF/Hughes *AIM-47A* air-to-air missile and the Navy/General Dynamics *Standard* missile, normally a surface-to-air weapon, for the role of an interim air-to-surface anti-radiation missile (*ARM*) (M/R, May 23, p. 9). It is expected that only one will be selected for the interim-*ARM* role.

Apollo 203 Launch Moved Up

Launch of the *Apollo* 203 flight has been set for June 30, about a week ahead of the previous date. Carrying only a dummy spacecraft, this flight will be a test of the reaction of the liquid hydrogen in the *Saturn IB* second stage to the space environment. Second unmanned test of the *Apollo* spacecraft, *Apollo* 202, is to be launched in August. If these earlier flights are successful, the first manned flight could come in the last week of November.

Ten Years Seen for ASMS Development

Navy is intensively studying ways to cut the time needed to develop and deploy its *Advanced Surface Missile System (ASMS)* for fleet air defense. Current estimates of 10 years are considered unacceptable. While the new *Standard* missile will be deployed before *ASMS*, the latter system is the only one in which the missile will be designed for such high speed and high maneuverability that it will be clearly superior to current or future high-performance aircraft.

Minuteman Retrofit Begins This Summer

Air Force will begin retrofitting 800 *Minuteman I* missiles to the *Minuteman II* configuration this summer. Test program with the *II* has chalked up 18 successful flights in 19 attempts. Wing VI of the 1,000-missile force is being equipped with *Minuteman II*. Also, continuous propellant tests indicate individual expected life now is five years.

Astronauts Win Radar Battle

The astronauts have won a battle with top NASA manned space flight officials at Headquarters and the Manned Spacecraft Center. As a result, the agency will use a radar in the Lunar Excursion Module's rendezvous system rather than an optical device. The astronauts favored the radar system, developed by RCA, primarily because they have experience with it in the *Gemini* program. The others were in favor of the optical system, developed by Hughes Aircraft, because of a large weightsaving. RCA now will build flight radar units for all of the LEM spacecraft. Low-key development of the optical system will continue and it may eventually be flown as an experiment on a future *Apollo* flight.

Red Long-Range Bomber Fleet Set at 100

Soviet Union now has only about 100 long-range bombers capable of making a round-trip attack against the continental United States, according to Secretary of Defense McNamara. The Secretary also reports that the strength of the Soviet long-range bomber force is less today than estimates several years ago indicated it would be, that it does not include a supersonic long-range bomber, and that the Soviets do not appear to be developing a new manned bomber.

Redeye Follow-on Is Deferred

Army proposals that development of a follow-on to the shoulder-fired *Redeye* anti-aircraft missile be initiated (M/R, Nov. 1, p. 14) have now been deferred for at least a year. At the same time, it has been disclosed that anywhere from 50 to 70 two-man deployment teams for the *Redeye* will be set up within each Army division equipped with the weapon. *Redeye*, now entering production, has slipped a total of 2½ years in the R&D cycle. Development costs, approaching $60 million, are double the initial estimates.

Nuclear Rocket Test Series Begins

NASA and the Atomic Energy Commission will begin a new series of nuclear rocket engine tests this week using the new NRX-A5 reactor. The series will last for several weeks. Firings are designed primarily to check out design improvements in the reactor and provide data on increased power operation of the reactor.

INDUSTRY

Hughes Tests Towed-Array Sonar

Hughes Aircraft is testing a towed-array sonar system able to follow submarines to great depths. The system is trailed at some distance from a surface ship to cut down interference from ship-generated noises. The project is part of a sonar development program in its third year at Hughes under a Navy Ship Systems Command contract.

Douglas Delivers First Long Tank Thors

Douglas Missiles and Space Systems Div. has delivered the first of 22 new long-tank *Thor* boosters to Air Force Space Systems Div. (see p. 28). The long-tank *Thor* is 70 ft. in length, compared with 56 ft. for the standard version. It is eight feet in diameter throughout its length without taper at the top. Rocketdyne's MB3-111 main liquid engine and three strap-on Thiokol TX-354-5 Castor II solid motors provide a total thrust of 330,000 lbs.

INTERNATIONAL

COSPAR Attitude Angers Delegates

Some delegates to the COSPAR (Committee on Space Research) meeting in Vienna last month still are angered by what they consider cavalier treatment by the COSPAR secretariat. Program for the meeting changed constantly as it proceeded. Preprints existed only in limited numbers or not at all—with the exception of the U.S. national report. While stringent rules of scientific significance bound most of the information given by Western delegates, many of their Soviet counterparts were allowed to give book reviews, abstracts of papers or papers by title alone. Some Soviet delegates admitted their papers were being held for "more significant" forums in Europe later this year.

Block Seen in Franco-Soviet Cooperation

A major stumbling block lies in the way of France's flirtation with the Soviet Union on space cooperation. The French are demanding to be at the launch site when French equipment goes aloft—just as they are allowed at U.S. sites. There is little chance of this. Many Soviet scientists are not even given the privilege.

The Aerospace Week

Soviet ICBM Report Awesome

The Soviet Union has brought its offensive missile strength up to the level of the U.S. and is now in the preliminary stages of deploying an operational anti-ballistic missile defense system.

This was reported June 2 by Dr. Finn J. Larsen, Deputy Director of Defense Research & Engineering, at a dinner meeting in Washington only hours after a Defense Dept. conference with President Johnson.

Larsen twice referred to Soviet ICBM strength as being close to the U.S. level and said that if there was any gap, it is "modest."

"There is very convincing evidence this is the case," he said.

Larsen said the U.S. in the last few months has accelerated a significant penetration aids effort to meet the Soviet threat. He mentioned both the *Poseidon* and the new *Minuteman* third stage in this regard. The Soviet capability was described as a "quick-reaction" threat.

The U.S. must now be prepared to defend its ICBM sites against a Soviet first strike, said Larsen. He urged deployment of a U.S. A-ICBM system and added, "It must be a system with growth potential of some kind."

(Reference to "quick-reaction" missiles by Larsen could mean either solid-fueled ICBM's, which would contradict recent claims by Secretary of Defense Robert S. McNamara, or could imply major improvements and widespread use of storable liquid-fueled ICBM's [see p. 17]).

Commenting on the lack of capability of U.S. missiles in Vietnam, Larsen said that less than one-third of U.S. anti-radiation missiles are hitting the target. In what was presumed to be a reference to the *Shrike* missile, Larsen said that it is not known what is happening to the second one-third and it is known that the remaining one-third are missing the target.

Navy Admits Training Curbs

Top-level Navy officers have confirmed reports that budget restrictions have resulted in sharp reductions from service-recommended levels of air-to-air missile firings for pilots in combat training (M/R, May 16, p. 14).

Chief of Naval Operations Adm. David L. McDonald has told the House Armed Services Committee that "in the case of the *Sparrow* missile, the fact simply is this: for the last few years we have bought training missiles on the basis of about one-fourth of a missile per pilot per year. Today we are making certain that every pilot, before he is deployed out West (Vietnam), will fire at least a missile. . . ."

McDonald said the Navy should have "at least twice as many training missiles (actual operational missiles) as we have had."

A program is now under way to expand the number of live firings per pilot to see whether it raises combat efficiencies.

Particularly troublesome has been pilot inexperience in missile performance in high-g maneuvers such as those experienced in dogfights. Failure to fully realize missile limitations in responding to commands under high-g loads has resulted in missiles being expended when the chances of hitting the target were very low.

Experience in Vietnam thus far (M/R, March 28, p. 45), operating under ground rules which require visual identification of the target, precludes some of the more straight and level intercepts for which most missiles are designed and for which pilots are trained. This results in dogfights in which basic physical limitations of both heat-seeking and radar-homing missiles are encountered.

Ocean Bill Passes Congress

The Senate last week gave final Congressional approval to a modified oceanographic bill creating a 15-member National Commission on Marine Science (M/R, May 30, p. 12).

The commission will make an 18-month study on marine science, engineering and resources, report to the President on its findings, then go out of existence.

NASA Aeronautics Role Probed

The possibility of an enlarged National Aeronautics and Space Administration with a separate budget for aeronautics and a mission to carry aeronautical technology into the advanced development phase has been raised in a Senate Space Committee policy planning document.

The committee, chaired by Sen. Clinton P. Anderson (D-N.M.), pointed out that the Congress has been increasingly concerned that aeronautical development has been neglected in favor of the more glamorous space program.

Concern of the Congress has stemmed from the fact that NASA's aeronautics budget accounts for only $124 million out of about $5.012 billion, about 2% for FY 1967.

In a compilation of data on the field by the Library of Congress, the point is made that it is perhaps almost surprising that NASA's efforts in aeronautics have not suffered any more than they have, since they have to compete with the space program.

A solution would be to put together a national aeronautics budget consisting of the appropriate activities in NASA, the Federal Aviation Agency, the Dept. of Defense and the Dept. of Commerce.

No Saturn Delay Foreseen

Damage to the static test stand from the May 28 explosion of a liquid hydrogen tank of a ground test version of the *Saturn* S-II stage was slight, NASA officials said, and will not delay the flight schedule of the *Saturn V*.

The explosion occurred at the Mississippi Test Facility during a pressurization test called when a leak was detected during the final of five static tests of the five J-2 engines.

Delivery of the actual flight stage S-II is now slated for July, some four months behind schedule. Repairs to the stand are expected to be accomplished before that time.

Shots of the Week

The *Surveyor* spacecraft was launched May 30 from Cape Kennedy and successfully soft-landed on the lunar surface on June 2 (see p. 14).

- An *Atlas* booster successfully orbited the Augmented Target Docking Adapter June 1 for a planned rendezvous with the *Gemini 9* spacecraft. However, launch of the *Gemini-Titan* was delayed due to trouble in a data transmission system (see p. 18).
- Two *Athena* test missiles were fired May 27 from the White Sands Missile Range test complex at Green River, Utah.

Air Defense System Funded

General Electric's Missile and Armament Dept. will manufacture the self-propelled XM-163 Vulcan Air Defense system under an initial $4.777-million contract from the U.S. Army Weapons Command, Rock Island, Ill.

A portion of the funding will be used to purchase production tooling for the VAD system. The GE unit uses the 20-mm Vulcan gun, a six-barrel, Gatling-type weapon with a 3,000 round/min. variable dispersion ability.

Navy Outlines Bomb Status

The House Armed Services Committee in recent budget testimony heard a status report on the ubiquitous "Eye" series of weapons under development or production for the Navy.

The heavily used "Snakeye," 250- and 500-lb. low-drag bombs, will hit maximum production rates by the first of the year. Several new production lines have been opened.

"Sadeye," a new air-launched cluster bomb designed to deliver a large number of bomblets from level glide, dive, or toss delivery modes, is expected to be approved for service use by this spring. The FY '67 buy is not expected to be large.

"Weteye," a new non-lethal chemical bomb to replace the Mk 94, is undergoing evaluation for operational use. The program has slipped about seven months, but will be bought initially with FY '67 funds.

"Rockeye," a new cluster bomb which contains anti-tank and anti-personnel bomblets, has gone into accelerated development with emergency funds to allow FY '67 procurement.

"Fireye," a new firebomb, will also be produced in FY '67; however, the new burning agent intended for the bomb will not be ready for procurement at the same time as the new container is ready. More conventional napalm will be used initially.

Surveyor Management Scored

Criticism of management of the *Surveyor* program is continuing despite the successful mission last week.

The General Accounting Office has sent a report to Congress charging officials at Jet Propulsion Laboratory with incurring extra costs of about $2.5 million on instruments which were initially ordered but could not be carried on the 2,100-lb. spacecraft.

However, NASA said that the instruments are still candidates for later *Surveyor* and other missions, and development was never terminated.

McKenzie To Head Aerojet

Reginald I. McKenzie has been named president of Aerojet-General Corp. He succeeds William E. Zisch, who has been appointed vice chairman of the board of directors.

McKenzie was promoted to executive vice president last March. He joined Aerojet in 1945.

Several thousand scientists and engineers will see this message, but . . .

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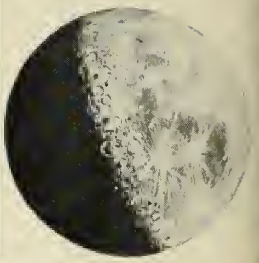


Never, in the history of man, have so many people applied so much talent to the accomplishment of a single technological objective: the scientific exploration of space.

The first step is the moon.

The vehicle that will carry the first Americans to the moon and return them to earth is called Apollo.

the start

The Apollo had its beginning on May 5, 1961, when Commander Alan B. Shepard, Jr., was launched from Cape Canaveral in a Mercury spacecraft in the first U.S. manned sub-orbital space flight.

Since that day, the moon has been seen in a new light — a goal obtainable for man. And now, America stands on the threshold of its first flight to the moon.

Today, some 300,000 people, in more than 20,000 companies, throughout the United States, are devoting their talents and energies to the fulfillment of that goal.

The lunar program demands their utmost effort because it is, without question, the most intricate industrial project ever attempted in history.

mercury & gemini

The way for the Apollo lunar vehicle has been paved by the first two series of space vehicles — the Mercury and the Gemini.

The Mercury series of one-man space flights, and the Gemini series of two-man flights, provided the experience necessary to start the far more complex task of reaching the moon.

While the previous orbital flights carried astronauts 200 miles from earth, the Apollo vehicle must carry man a quarter-million miles into space and return him to earth.

In size, the Apollo/Saturn is three times as tall as the Gemini/Titan. The Apollo spacecraft alone has a payload six times greater than the Mercury and Gemini spacecraft combined.

ITCH CONTROL
TCH C
RADIO ANTENNA

the challenges

Besides the significant differences in size and weight, the Apollo is far more complex than earlier space vehicles.

During its 478,000-mile round trip journey through an alien environment, the spacecraft will be making its way over an oppressive obstacle course—through the Van Allen belts, through proton storms from solar flares, through rains of micrometeorites, through interplanetary vacuum, through extremes of temperature from minus 250 degrees F. to over 6000 degrees F.

The Apollo will constantly change speed under the influence of varying gravity forces from the earth, the moon, and the sun. And it will perform extremely complicated maneuvers in space including an intricate rendezvous while in lunar orbit.

But, despite the complexity of the system, the Apollo/Saturn program will be on schedule for the flight to the moon.

apollo/saturn progress

In late February of this year, the Apollo/Saturn made its first flight. It was an unmanned, sub-orbital flight and covered more than 5,000 miles in its downrange flight from Cape Kennedy, landing just 38 miles from the recovery ship.

At more than 45,000 pounds, it was the heaviest U.S. payload ever launched.

During re-entry at a speed of about 18,000 mph, the spacecraft survived temperatures twice as hot as either molten lava or the melting point of steel.

The flight was the first in a series of planned sub-orbital and orbital tests leading to the lunar launch.

The Apollo/Saturn program is being conducted under the direction of the National Aeronautics and Space Administration.

North American Aviation is a prime contractor on the program with responsibility for the Apollo spacecraft, the second stage of the Saturn V launch vehicle, and the rocket engines for all three stages.

NASA, North American, and some 20,000 other companies are all meeting the challenge of the exploration of space.

Their efforts are leading to what will be the greatest technological event in history.

North American Aviation

Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Science Center, Space & Information Systems

Surveyor Program Leapfrogs Ahead

by Rex Pay

Pasadena, Calif.—The resounding success of *Surveyor 1* on its maiden mission has pushed the program ahead a full year, according to NASA officials.

The spacecraft has provided extensive visual, mechanical, electrical and thermal data on the lunar surface, and has proved the feasibility of a closed-loop descent to a gentle touchdown.

The flight took a little more than 63½ hours from liftoff at 9:41 a.m. EST May 30 at Cape Kennedy until the spacecraft settled on the Moon at 1:17 a.m. EST June 2.

Initial indication was that the local surface of the Moon is not dust on hard rock, but consists of a fairly strong but penetrable layer. The Lunar Excursion Module could land *Apollo* astronauts at the *Surveyor* site, according to initial examination of the impressions made by the spacecraft's landing pads.

Further analysis of the bearing strength will come from a more detailed television survey of the entire surface around the spacecraft, from the crust deformation around the landing pad, and from strain gauge readings obtained during landing.

An immediate indication given by the *Surveyor* pictures, said Project Scientist Leonard Jaffe, is that rubble—rocks larger than a foot across and as small as a fraction of an inch—is liberally strewn across the Moon's surface.

Numerous craters were visible in the photographs. One 25-30 ft. away from the spacecraft was about 10 ft. across. Measurements of the strength of the radar echoes obtained by the spacecraft's descent radar will indicate the electrical properties of the lunar surface. Analysis of the thermal behavior of the spacecraft as it sits on the surface will indicate temperatures.

Leapfrogging—The success of this first mission, said R. F. Garbarini, NASA Headquarters, means that later missions can observe other regions of the Moon and discover how representative this initial landing site is.

It had been anticipated that it would take three to four flights over a period of a year to get the spacecraft operational, said Garbarini. "As a result of this very fine flight, it puts us approximately one year ahead as regards the current *Surveyor* program. . . . We now have more spacecraft to carry out more site surveys."

The *Surveyor* landing "will provide confidence in the LEM landing gear, as it is patterned on the *Surveyor* landing gear," he added.

Surveyor Project Manager Robert Parks said an unusual landing sequence was adopted because omni-antenna A failed to deploy. This enabled communication with the spacecraft to be maintained throughout the maneuver through omni B alone.

The total roll maneuver put the spacecraft down on the surface in an excellent orientation to take the initial pictures of the lunar surface. However, the position is such that the spacecraft camera cannot be aimed high enough to take a picture of the Earth from the Moon. Also, the spacecraft structure will prevent viewing the lunar surface in the direction of the Sun at lunar sunset, where maximum information on surface structure can be obtained from shadow patterns.

The spacecraft was not expected to last more than 10-30 hours into the lunar night as its battery will fail to meet the increased heating load required to keep its compartment temperature within limits. *Surveyor's* life on the moon is expected to be 12-13 days.

Terminal maneuvers—Instead of the normal roll and yaw, the spacecraft made inital roll, then a yaw, and then a second roll. This was made possible by the precision of the mid-course maneuver and by an inertial gyro drift that was much less than specified. The low drift enabled the complex maneuver to be started earlier than was anticipated.

"This put a little bit more pressure on the operational crew, but they performed marvelously," said Parks. "The spacecraft responded precisely and accurately to all commands," he added.

Surveyor demonstrated for the first time the capability of a ground operating crew to continuously control a spacecraft during its flight to the Moon and after landing. The spacecraft performance was monitored all through the flight and adjustments made to the command sequences sent to it. About 300 direct commands were sent to *Surveyor* during its flight phase, in comparison with 11 sent to *Ranger 7*.

Post-landing control—Both tape and keyboard commands were used during the photographic sequences of the first mission. Spacecraft operation crews and the scientific investigators were reported to be cooperating smoothly, with the scientists having no special difficulty in keeping up with the amount of picture data being fed to them.

They were able to evaluate it and make decisions as to what should be viewed next. The ability to carry out this form of real-time operation of a survey instrument on the Moon was an important design consideration for the Space Flight Operations Center.

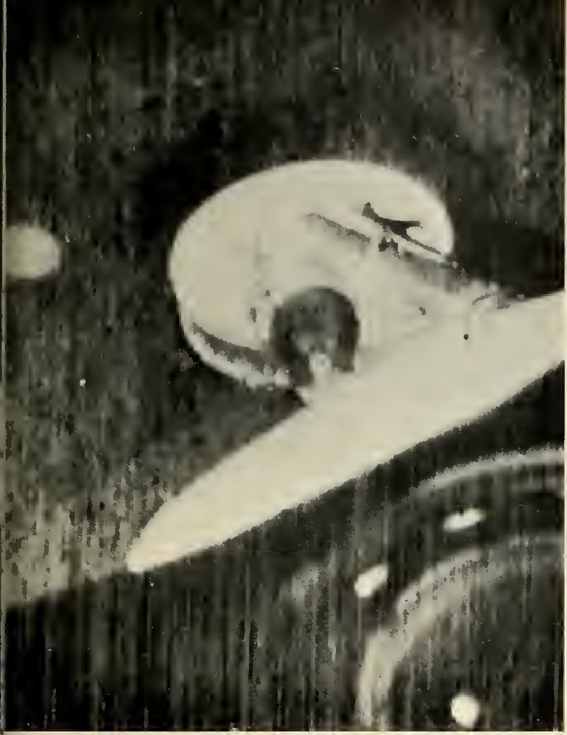
Operation of the *Surveyor* equipment on the Moon was also a convincing demonstration that an ability had been developed to position the parts of a spacecraft—solar panel, antenna, camera—with great precision by Earth command.

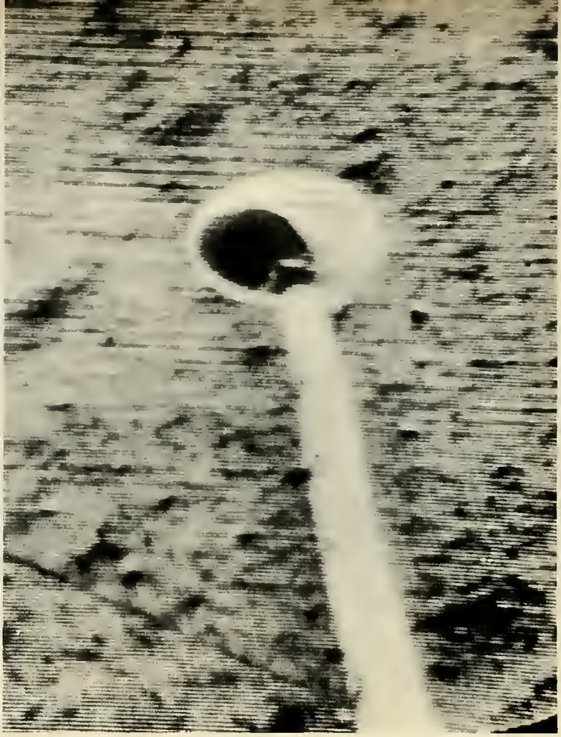
Some 34 min. before retro-ignition, the terminal maneuver was initiated with an 89.3-deg. roll. This was followed by a 59.92-deg. yaw and then by a second roll of 94.20 deg. It was then about 29 min. before retro-ignition. The spacecraft remained completely stable during the maneuvers. Signal strength was 128.2 dbm, close to the cruise level before the maneuver.

The spacecraft had been lined up with the thrust axis of the retro-rocket pointing along the line of flight. During retro-fire this alignment was maintained, enabling *Surveyor* to make a gravity turn before descending under thrust from its three vernier engines alone.

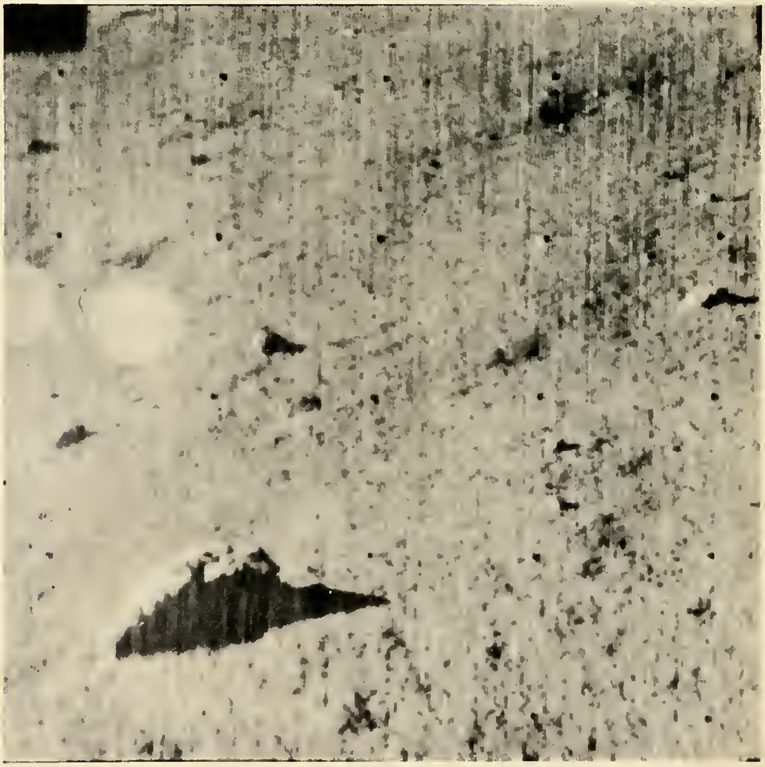
Deviations from plan—Activation of the downward-looking television camera was not carried out at this time, as this would have deprived the ground crew of important telemetry at a critical point in this first mission. It will be used in later flights to view the portion of the Moon that *Surveyor* is approaching.

Another deviation from the standard sequence occurred. When the thrust bias for the vernier engines, to be applied during main retro-thrusting, was inserted, it was for full thrust rather than the half thrust normally required. This raised the margin of stability to take care of any center-of-gravity disturbance caused by omni antenna A remaining in the stowed position. Again, this was made possible by the small mid-course maneuver resulting from excellent performance by the *Centaur* guidance system.





ABOVE LEFT: *Surveyor landing foot rests on lunar surface. Dark area above foot is depression caused by foot's impact. Photo was made on 200-line-scan TV camera. Bright spot is reflection of Sun.* RIGHT: *Photo taken from TV monitor at JPL shows antenna and lunar surface. This is a 600-line TV transmission.* BELOW: *Lunar rock at lower left is described as being 6 in. high and 12 in. long. Camera was pointed southeast when this photo—the 10th transmitted—was taken.*



Next command sequence inserted a delay time of 7.826 sec. into the altitude-marking radar. This meant that retro-ignition was planned to occur 245,450 ft. above the Moon, at an anticipated velocity of 8,567 fps. To back up the altitude-marking radar signal, an emergency ignition command was sent to turn on the retro at 1:14:37 a.m. EST June 2.

A check was then made of the engineering measurements sampled by engineering commutator number one, that used during the touchdown phase. Commutator data was then checked. Receiver B and decoder A were selected at this time for use during the remainder of the descent sequence.

Television system outputs were reset some 12 min. before retro-ignition. Four minutes later the retro-firing telemetry mode was turned on. Radar power was turned on 7 min. later.

Some 3½ min. before ignition, thrust phase electric power was commanded on, and its operation was confirmed by telemetry. Two minutes later the altitude-marking radar was set to fire the 8-10,000 lb.-thrust retro after the specified delay from the time it first sensed the Moon.

A mark signal indicating that the AMR had sensed the Moon then came precisely at the expected time. Retro-ignition followed the programmed delay. *Surveyor I* weighed 2,194 lbs. at launch. After jettisoning its burned-out retromotor it weighed 620 lbs.

Retro function—Stable retro-ignition was confirmed by the time the spacecraft had descended to 116,000 ft. and was traveling at 5,148 fps. Sample altitudes and velocities called out then went as follows: 63,000 ft., 3,900 fps, decelerating at 8 g; retro burnout confirmed at 32,000 ft.; 28,000 ft. and moving at 400 fps; 24,000-ft., moving at 425 fps. The spacecraft was then under closed-loop control from the radar altimeter and Doppler velocity sensor. Engineering commutator three was in lock and strain gauge data was being sampled; 12,000 ft. and 400 fps; 8,000 ft., 250 fps.

At 4,000-ft. the spacecraft was reported to be in stable flight. Altitude readings dropped through 1,000, 600, 200, and 100 ft., with velocity falling to 100 fps. Next velocity reading was 13 fps.

The spacecraft then touched down at 1:17:37 a.m. EST.

Transmission from the spacecraft continued throughout descent and touchdown. Telemetry lock was maintained through descent and touchdown. S-band signals were coming from *Surveyor* at a level of 125.5 dbm as it sat on the surface of the Moon at 2.49° south latitude, 43.32° west longitude. Target coordinates were 2.34° S. and 43.35° W.

Thrust phase electrical power and the radar altitude and Doppler velocity sensor were turned off. Commutator mode 2 telemetry was good. The touchdown strain gauges were turned off and the landing gear locked.

Preliminary analysis of the strain gauge data confirmed a soft landing.

Taking pulse—Coast phase telemetry was turned on and 120 different points in the spacecraft system were sampled to assess its condition. Signal strength at the Goldstone tracking station was measured as giving a 10-db margin for transmission of 200-line television pictures over omni antenna B. Everything looked good.

A test of omni A showed its signal strength was —133.6 dbm, indicating that it had probably extended on touchdown. Telemetry from the spacecraft also indicated this. Sun angle was found to be 28°

Mode 4 engineering data was turned on for a further investigation of the spacecraft's condition, indicating compartment A temperatures and survey camera temperatures, confirming the venting of helium from the vernier engines, and giving readings from many other points.

As confidence in the spacecraft's condition grew, a switch to the non-rechargeable auxiliary battery was made and a sequence of camera tests made prior to picture taking. This conserved power in the 14-cell rechargeable silver-zinc main battery. The camera iris servo was turned on and the decision was made not to change the pre-set camera.

Picture-taking—After a return to initial conditions, a 200-line picture sequence was started.

First picture taken by *Surveyor* showed its number 3 pad and the lunar terrain it rested on. The terrain was underexposed. The spacecraft—very bright—was clearly visible. Close examination showed the pad had penetrated the surface.

The mirror was stepped to the right 12° and up 5° and the iris closed down to yield a picture of the terrain. An antenna was in clear view over a granular terrain strewn with small rocks. The antenna was omni B.

Following this picture-taking to check out the camera, the remainder of spacecraft checkout was carried out. High-power interrogation of coast phase telemetry took place. The roll and elevation mechanisms on the *Surveyor* mast were unlocked and stepping through both axes was confirmed. This was a crucial test. It indicated that a long life could be expected from *Surveyor* as it could direct its 3,960-cell solar panel to the Sun. If it could not do this, it would become silent as soon as its batteries ran down.

By 1 hr., 4 min. after touchdown, the spacecraft had gone through all its planned engineering tests and a JPL spokesman announced that everything had worked properly.

Within the six minutes the ground stations were being reconfigured for 200-line television reception, in preparation for a series of 11 pictures surveying the Moon between pads 3 and 2, stepping 6° to the right each frame. Toward the end of the sequence, the camera mirror tilted up to give the first view of the horizon, which appeared quite smooth.

"We selected the landing area because it looked level from here, and it looks level now," commented a JPL spokesman.

At landing, the spacecraft's gyros had indicated a generally flat surface, probably only a few degrees off the horizontal. About 3¼ hours after landing, the solar array and the high-gain antenna had been positioned for transmission of high-definition, 600-line television pictures at 4,400 bits per sec. Received signal power was —101.7 dbm.

The solar panel is a thin flat surface of about 9 sq. ft. providing 77w at 140°F. It charges the main battery to a maximum capacity of 3,800 watt-hours. Battery output is about 22v when its compartment is held between 40° and 125°F.

In the low-power mode, the spacecraft's transmitters put out 0.10w. This power is raised to 10w for high-resolution transmission and transmitted through a high-gain planar phased-array antenna. In the high-resolution mode, the transmitter is fed directly by the television camera video, a 600-line picture being relayed every 3.6 sec. In the low-resolution 200-line mode, a frame is transmitted every 61.8 sec.

Optics—The camera can be commanded to focus from 4 ft. to infinity and can be adjusted to either a narrow 6.4° field of view or a wide-angle 25.4° field of view. A focal-plane shutter provides an exposure time of 150 milliseconds, or it can be opened on command indefinitely. A light-level sensor prevents the shutter opening, however, if light is too intense for the vidicon tube. This tube is 6 in. long, 1 in. in diameter and weighs 2.5 lbs.

The tube and its lens system are mounted nearly vertically, pointing at a movable mirror that is used to scan the lunar scene. A filter wheel in the light path can be commanded to one of four positions providing clear, colored, or polarizing filters.

Taking temperature—In the high-resolution mode, the camera was commanded to go through standard sequences of sector scanning for about 30 min., using wide- and narrow-angle lens settings. This was followed by a period of engineering telemetry to evaluate the temperature rise taking place in the television system and associated units. Further picture sequences followed interspersed with engineering analyses. Some 144 pictures were obtained during this first period of viewing the spacecraft on the Moon from Goldstone.

At the end of the sequence, transmitter A had reached a temperature of 104°F and transmitter B had reached a temperature of 91°F. Sunlight reflected from the surface of the Moon was raising the temperature of the lower parts of the thermally insulated compartments. Compartment A was registering 99°F at the top and 116°F at the bottom. Compartment B was registering 87°F at the top and 94°F at the bottom. Each compartment has a maximum operating temperature of 125°F.

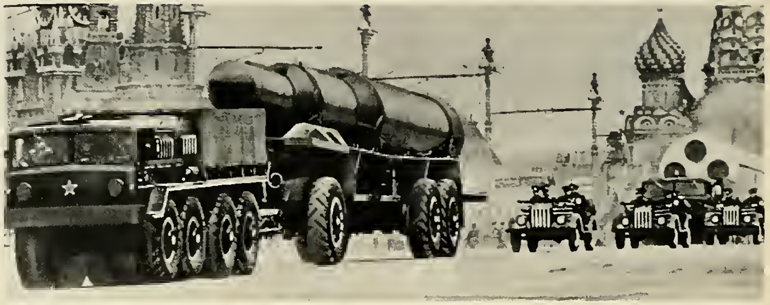
At about 9:20 a.m. EST June 2, the Moon—and the spacecraft with it—dipped below the Goldstone horizon.

Goldstone will continue to be the prime station for picture sequences, while Canberra and Johannesburg will concentrate on engineering assessments of the spacecraft. Canberra can also receive picture information, storing it on magnetic tape and 35-mm film. Pictures cannot be received at Johannesburg.

Next *Surveyor* is due to fly in the third quarter of this year, and will have the same configuration as *Surveyor I.* ■

Soviets Still Lack Solid-Fuel ICBM's

by Michael Getler



"Little Sister," described by Russians as a solid-fueled intercontinental-range ballistic missile, passes through Red Square during May 9, 1965, Moscow parade.

WASHINGTON—Nearly a year after the Soviet Union showed for the first time what it claimed were solid-fueled intercontinental-range ballistic missiles in a Moscow parade, U.S. Secretary of Defense Robert S. McNamara asserts that the Soviets still do not possess operational weapons of this type.

The secretary's most recent insistence that solid-fueled ICBM's do not constitute part of the current USSR long-range missile inventory came in discussion of the Fiscal Year 1967 budget before the House Appropriations Committee.

In testimony taken in February but released just last month, Secretary McNamara, when questioned on Soviet solid-fuel missile developments by Congressman Daniel J. Flood (D.-Pa.), said only that "We assume they are working on it." When asked by Flood: "How do you explain that? What is the matter with them?" McNamara said that he "did not understand it, other than that they got started on a particular technical tack and have followed it."

Flood's insistence that this was "hard to believe" elicited another "I do not understand it" from the secretary, who went on to say that "we must assume that they will eventually develop solid-fuel missiles and deploy them because of their operational advantages."

Secretary McNamara has publicly downgraded Soviet claims about solid-fuel missiles before, but this latest statement is the first to follow the Moscow parade of May 9, 1965.

The secretary's remarks therefore cast doubt specifically upon the three-stage *Minuteman*-size ICBM known by the NATO designation of *"Savage"* and sometimes called *"Little Sister;"* and also upon the shorter-range, mobile, *"Scamp"* or *"Iron Maiden"* (M/R, May 17, 1965, pp. 16-17). *"Scamp"* has not been seen by Westerners without the heavy casing that surrounds the missile.

Support for McNamara—U.S. experts in Soviet technical affairs report general agreement with McNamara's current assessment.

One well-informed scientist told TECHNOLOGY WEEK that "there is certainly no indication that the *'Savage'* missile has even been flight tested." This implies that even if the missile shown in Red Square was an early R&D model, it may still be a few years away from operational deployment, if the Soviets decide to deploy it.

Detailed monitoring of Soviet ballistic missile test flights by the U.S. is accomplished primarily by radar; both those based around the Soviet Union and probably—in more recent months—by new long-range over-the-horizon radars put into service.

Solid-fueled missiles, which generally accelerate much faster than liquid-fueled missiles, can be fairly accurately differentiated by radar. Scientists feel that even tests of intermediate range (1,500-2,000 mi.) weapons, such as *"Scamp"* is believed to be, could not readily escape detection.

These same sources believe that operational Soviet solid-fueled missiles do not extend beyond the tactical category, limited to ranges well under 1,000 mi. The Soviets are developing a *Polaris*-type solid-fueled submarine-launched missile (M/R, April 4, p. 12) but the range is also believed to be less than 1,000 mi.

Assumptions discouraged—While the U.S. has had considerable success with solid-fuel missiles, such as *Polaris* and *Minuteman*, and the very rapid response time possible with this sort of weapon adds immeasureably to U.S. strategic posture, some Soviet affairs analysts caution against too many assumptions as to the intentions of the Soviets in this field.

The Soviets unquestionably have been interested in, and working hard at, solid-fuel missile development for several years, especially when confronted with U.S. gains. But some observers believe that economic pressures and improvements to the existing Soviet liquid-fueled ICBM force—achieved by using storable liquid fuels, by hardening more missile silos, and by better early-warning systems—may have taken some of the pressure off for large-scale deployment of solids and allowed for postponement or stretch-out of the program.

Some scientists also believe that much of the Soviet solid-fuel technology is being devoted to anti-ballistic missile development, where extremely-high-acceleration solid-fueled missiles are most practical, but again, where large size and very long range are not required.

Both government and civilian observers of Soviet affairs confess the difficulty of assessing Russian military missile program directions. Part of the problem is that statements made by the Secretary of Defense, which run headlong into Soviet statements to the contrary, are made with no further supporting public testimony.

There was also good cause several years ago to suspect that the Soviet chemical industry could not meet the challenge of large solid-motor design, particularly in engine nozzles and propellant oxidizers. While solid-fueled missiles are simple operationally, their chemistry is highly complex. But many scientists well versed in solids now tend to credit the Soviets with competence in this area. ■

Gemini 11 To Create Artificial Gravity

WASHINGTON—NASA officials have approved a new space spectacular for the *Gemini* program, which now may be completed in late October.

The new feat which will be attempted during the *Gemini 11* mission calls for creating artificial gravity in space for the first time by tying the *Gemini* spacecraft and the *Agena* target vehicle together with a long tether (M/R, May 23, p. 18.)

The two vehicles would then be twirled to create the artificial gravity.

The change in the program and the accelerated schedule were revealed as the *Gemini 9* launch was delayed again from June 1 to June 3 when a black box in the ground support equipment malfunctioned. If the launch go-ahead was given late last week and if the mission is completed successfully, Command Pilot Thomas Stafford, Pilot Eugene Cernan and the *Gemini 9* spacecraft will return to Earth early on June 6 with impact in the Atlantic Ocean.

No other changes—The inclusion of the artificial gravity equipment is the only major change expected to be made in plans for the remaining *Gemini* flights, a NASA official reported.

Two other changes in future flight plans which have been proposed—tetherless extravehicular activity (EVA) using the Astronaut Maneuvering Unit (AMU) and rendezvous of the *Gemini* and *Apollo* spacecraft—have almost no chance for approval.

The rendezvous of the two spacecraft would be approved only if the *Gemini 12* launch and the first manned *Apollo* flight are made close together in the last week in November. At this point, that appears highly unlikely.

The *Gemini* schedule, if all goes well, now calls for *Gemini 10* to be launched on July 18, *Gemini 11* in mid-September and *Gemini 12* in October.

The tetherless AMU activity is opposed by Dr. George E. Mueller, associate administrator for manned space flight, and other top officials. They do not believe the knowledge gained from such activity is worth the danger involved. The situation could change, however, if tethered extravehicular activity on the *Gemini 9, 10,* and *11* flights is successful.

The artificial gravity experiment was proposed by *Gemini* program officials at the Manned Spacecraft Center. TECHNOLOGY WEEK learned late last week that it had been approved by top agency officials for inclusion in the *Gemini 11.*

The ability to create artificial gravity in space is considered very important primarily because it will make astronauts far more comfortable. It is also hoped that this will prevent deconditioning of the cardiovascular system and possible loss of calcium.

Besides producing artificial gravity, the whirling *Gemini/Agena* combination will enable engineers to study the flight dynamics of such a combination and also provide data on the ability of a spacecraft to station-keep with a passive satellite.

Gemini 9 attempts—The *Gemini 9A* mission was first scrubbed on May 17 when the *Atlas* booster for the *Agena* target vehicle malfunctioned and failed to go into orbit.

Space agency officials decided to replace the lost *Agena* with the Augmented Target Docking Adapter (ATDA) vehicle. It was blasted aloft May 31 into an almost-perfect 161-n.-mi. orbit.

All attempts to launch the *Gemini 9* spacecraft, however, failed when officials were unable to update the *Gemini* spacecraft onboard computer with backup launch guidance data during the final three minutes of the count.

The count for the *Gemini-Titan II* liftoff was recycled to T-minus-3, the start of the automatic sequencing, prior to each of three attempts to enter updated guidance information into the computer.

Mission Director William Schneider ordered the mission scrubbed when *Gemini's* brief (5 min., 47 sec.) and only available launch window for that day had closed.

The mission was rescheduled for June 3, when astronauts Stafford and Cernan would have two favorable periods in which to attempt a rendezvous with the stubby target within the first three spacecraft orbits. The first window would open at 8:39 a.m. EST, the second at 10:15 a.m. EST.

If launched successfully late last week, the *Gemini 9* flight will attempt to achieve a rendezvous with the ATDA during its third revolution around the Earth. Cernan was also scheduled to attempt a 2-hr., 25-min. walk around the Earth on June 5 using the AMU for the first time.

Two other rendezvous and three docking maneuvers were also planned for the flight.

Failure pinpointed—Cape Kennedy officials reported the cause of the June 1 *Gemini 9* scrub was isolated to two logic modules in the inertial guidance system buffer—or ground equipment that interfaces the General Electric-Burroughs mod III launch guidance computers and the data routing and error detecting (DRED) unit.

The DRED receives data from the Mission Control Center and the launch guidance computers, checks it and reroutes it for proper distribution within the digital command system network at Cape Kennedy.

In the case of the *Gemini 9A,* the DRED received ATDA trajectory data computed in the real-time computer complex (RCC) of the MCC and routed it to the guidance computer. Pitch-azmiuth information calculated by the computers apparently was then successfully routed back through the DRED via hard line to the block house for input into the *Gemini* launch vehicle. Updates for the *Gemini* computer which are sent via RF link, however, must enter the IGS buffer for temporary storage in their routing to the DRED; this is where the data flow was interrupted.

Atlas launch—The *Atlas*-ATDA combination lifted off from Cape Kennedy's launch pad 14 only two seconds behind the scheduled liftoff time of 10 a.m. EST.

Mission Control Center reported two anomalies, based on ground telemetry readouts, which occurred shortly after the target separated from the *Atlas:*

There was no confirming evidence that the 90-in.-long, 300 to 400-lb. ATDA shroud which protects the target docking adapter during exit heating had jettisoned. If left in position, the shroud would prevent the *Gemini* crew from docking with the target after achieving rendezvous.

One of two reaction control systems thruster rings on the ATDA became unusually active, possibly indicating that the ATDA tended to become highly unstable after separation, and was depleted of propellant. A second redundant ring of eight 25-lb. thrusters was not activated. ■

Lockheed, Martin Are Picked For AAP Systems Definition

WASHINGTON—Two firms—Lockheed Missiles & Space Co. and the Martin Co.—have been selected to perform systems definition studies of the *Apollo* Applications program, for which a substantial number of experiments are expected to be approved in two to four months.

The firms will perform one-year parallel efforts funded at $1 million each. After the studies are completed and AAP is given the official go-ahead, one of the firms will be selected for payload integration of experiments into the *Apollo* Lunar Excursion Module, the *Saturn* launch vehicle instrument unit, and the top stages of the *Saturn IB* and *Saturn V* boosters.

Although officials had once hoped to fly *Apollo* Applications missions in the last half of 1968, the one-year study effort and lack of real hardware development funds until Fiscal Year 1968 have delayed the first flight until 1969.

The program calls for 45- to 90-day flights in Earth orbit, 28-day lunar orbiter flights and 14-day exploration missions on the lunar surface. Although the total number of flights has still not been firmed up, Associate Administrator for Manned Space Flight George E. Mueller recently told Congress that the space agency would like to make about three *Saturn IB* and three *Saturn V* flights per year.

Reportedly, the space agency hopes to have about 20 flights approved in the program over a three-year period.

Some experiments under way—Three experiments have been approved for the program and many more are expected to be approved in the near future.

Those which have received the hardware go-ahead are a low z cosmic ray experiment, high z cosmic ray experiment and a lunar photographic mapping experiment.

One official of the space agency estimates that 12 to 24 experiments will be approved in the next two to four months. Approval will have to be given soon so that experiments for early flights in the program will get the necessary leadtime required for development.

The fixed-price contracts will be managed by Marshall Space Flight Center, which has field center responsibility for the LEM and the launch vehicle portions of the program.

Manned Spacecraft Center has responsibility for payload integration of the experiments into the *Apollo* spacecraft Command and Service Modules.

Requests for proposals were issued by Marshall in January and nine bids were received. The losing firms include McDonnell Aircraft Corp., TRW Systems and Chrysler Corp., IBM Corp. and Boeing Co., General Electric Co., Douglas Aircraft Co., Goodyear Aerospace and General Dynamics.

Study details—The studies to be performed by the two companies will include consideration of mission analysis, experiment equipment, installation and integration of equipment, specialized crew requirements, launch facility requirements, and tracking and other support requirements.

Each of the firms will produce documentation for defining the next phase of the AAP effort, which is the development and operations phase. The two contractors will also submit proposals to doing work in that phase. ■

Advanced ABM Radar To Be Built

A new Advanced Design Array Radar (ADAR), an experimental system intended as a test-bed for long-range radars associated with future anti-ballistic missile systems, is expected to be completed in 1968.

The radar, being developed by Hughes Aircraft Co. under sponsorship of the Advanced Research Projects Agency (ARPA) and the Air Force's Rome Air Development Center, will press the current state of the art forward in several areas, according to project sources.

The project is an outgrowth of the so-called "Interceptor-X" study performed by the Institute for Defense Analyses several years ago to look at the kinds of technology beyond the then-current state of the art that may be needed in ABM systems beyond *Nike-X*.

The new radar apparently holds the promise of greatly improved components and systems performance in combination with reasonable cost.

The system will operate within the microwave region, but at much higher frequencies than do the present *Nike-X* radars. The system essentially is analogous in terms of tasks to the Multi-function Array Radar (MAR) of the *Nike-X* complex.

It is hoped that the higher operating frequency and associated narrow beamwidth and wider information bandwidth will provide much better pointing accuracy, target resolution, and identification capabilities. The higher frequency may also improve penetration of any nuclear disturbance preceding an attack.

The program was started about two years ago. A components development phase has just been completed. Design efforts on new receivers, transmitters and phase shifters were apparently sufficiently successful to warrant the current move into phase II, which involves building the radar.

The system will be built at Hughes rather than at a national range. It will cost about $15 million, according to project sources, and will allow test of new beam-forming and signal-processing techniques. ARPA Director Dr. Charles M. Herzfeld reports: "We think this is going to be a very important development."

At Hughes, the radar will be exercised primarily against aircraft and satellites, rather than ballistic missiles as it could be at a range, but scientists stress that at the current stage of development the experimental cost and performance data can be gained at the Hughes test site and at much less expense.

The new radar will depart considerably from conventional phased-array radar beam-forming techniques, but some of the methods developed in the Army/ARPA HAPDAR radar (M/R, March 14, p. 15) will be incorporated. The system will not include single transmitting elements for each antenna element, but it will have more than one transmitter for the entire array.

Bulk of the funding for the program is expected to be completed in Fiscal Year 1967, though a request to cover some final costs are expected in FY '68.

TRW To Study Land-Use Planning

TRW Systems Group has joined the growing list of aerospace firms being called upon to apply systems engineering experience to public needs.

The firm will design a regional land-use information system for the State of California's Office of Planning under a $200,000 contract. Portions of Santa Clara County will be used in a pilot demonstration of the system.

California pioneered in applying the skills of aerospace firms to large-scale civilian problems with the financing of four studies on transportation, waste disposal, information systems and juvenile delinquency (M/R, Feb. 15, 1965, p. 24).

Announcing the award, Dr. Ruben F. Mettler, president of TRW Systems, noted that "this is a significant step in actually applying Space-Age technology to the systemized collection and analysis of information needed to help in planning the utilization of land.

"With hundreds of thousands of new California residents entering the state, our major urban centers are quickly becoming overcrowded and the services they can render our citizens are becoming over-extended. The systemized planning of our land development and utilization will allow us to more wisely use our available resources to better accommodate and service the expected growth in our state's population, economy and development."

A growing number of city and county governments are moving toward use of automatic data processing techniques to handle vast amounts of information for administrative and planning purposes. The regional land-use system project will be of valuable assistance to them. Smaller communities lacking the resources to develop their own systems may also obtain design data from the regional system, TRW pointed out.

Information sharing—A major objective of the new regional system is more effective sharing of information between departments within a given government jurisdiction and between jurisdictions. Thus, the land-use system will take into account such factors as economics, political subdivisions, geography, physical location, legal jurisdictions and social implications. Since land use affects so many people, the new system must accommodate the diverse interests of users at local, regional and state levels, the firm said.

Mettler: ". . . systemized planning of our land development and utilization. . . ."

Another objective will be to obtain a concensus among all those with an interest in land on the range and type of information required. Surveys will be conducted not only of the cities and counties throughout California, but also of such land-oriented Federal agencies as the Bureau of Reclamation, Soil Conservation Service and Census Bureau. Special state districts—water, pollution and sanitation—will be consulted. Various departments at the state level—highways, resources, agriculture, education and finance—will also supply inputs.

A State-wide Information Steering Committee (SISC) will be set up to help establish and maintain the interfaces with these interested groups and to provide project guidance.

The SISC will consist of high-level public administrators in those agencies having an interest in land-use information. It will also help unravel such knotty problems as cost sharing among users of the generated information because it has an automatic data processing system and the existence of a long-range development program. Land use is considered one of the main factors in the county's program and is described in computer language adaptable to the new regional land-use system.

Five-step plan—TRW's proposal to Stewart L. Barnes, project director in the state's Office of Planning, outlined a five-point design program. First, surveys and analyses will be conducted to determine areas of existing and potential interest in land use. These analyses will be converted into user requirements which will then be interpreted in terms of technical factors such as data collection, data communications, data storage, data processing, report generation and information retrieval.

When the requirements have been agreed upon, the system specifications will be prepared. This is where Santa Clara will act as the proving ground. Once the specifications have been found adequate for the system, an implementation plan will be developed that will be time phased and reflect the evolutionary nature of land use. It is expected that the steering committee would play a major role in implementing the system plan.

California already has a state automatic data processing advisory committee functioning. The TRW plan calls for using this experience in designing the new system. TRW also suggested that the SISC should consider coordinating some of its activities with working committees of such organizations as the American Society of Assessors, the Urban Land Institute, the American Bar Association, the American Institute of Planners and the American Institute of Architects.

The TRW project will be under the direction of Dr. John J. Dulin. Ernst and Ernst, international certified public accountants and management consultants, will apply experience in land development, land-use planning and economic studies to the design of the new system as a subcontractor to TRW. The firm is presently conducting land studies in Santa Clara County. ■

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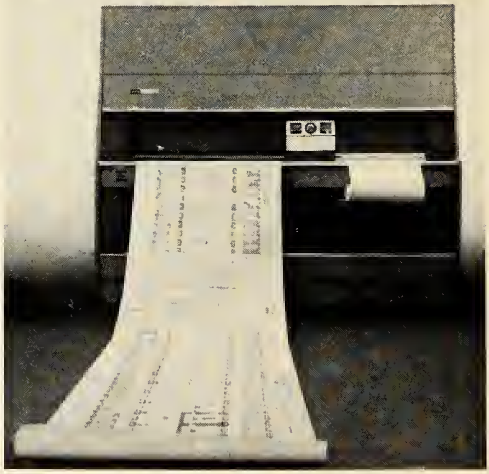

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Technical Countdown

BIOINSTRUMENTATION

New Temperature Sensor Developed

Honeywell, Inc., has developed a harness-mounted sensor for prolonged monitoring of human skin temperature which would obviate the use of rectal or oral thermometers in spaceflight. The unit, developed for the Air Force, utilizes a 30-in. x 1-in. ribbon held in close contact with the subject's chest by a harness on which other sensors are mounted. The temperature sensor is a length of No. 44 Balco wire (70% nickel, 30% iron), which is sealed between two layers of Teflon-backed pressure sensitive tape. Total resistance of the sensor is about 750 ohms at room temperature. Temperature coefficient is approximately 2 ohms per degree F.

Cardiac Measurement Shows Promise

A new method of measuring human cardiac output—a measurement which is generally accepted as a meaningful physiological parameter for assessing stressful, fatiguing work tasks—is being studied by scientists at the Physiologic Laboratories, Civil Aeromedical Institute. The method would use an ultrasonic transducer (UST) crystal located at the tip of a modified cardiac catheter, which would give volume measurements with cycles not exceeding 302 microsecs. Larger UST crystals placed externally on the anterior thoracic wall and focused on the cardiac area show promise as another means of obtaining ultrasonic echo patterns.

ELECTRONICS

Gas Bearing Friction Checked by Ultrasonics

Excessive friction conditions in gas bearing components for airborne gyroscopes are being detected ultrasonically at Litton Industries' Guidance and Control Systems Div. The test indicates bearing performance by predetermined decibel intensity levels and permits rejection of bearing components before final assembly. The unit consists of a hand-held probe microphone responsive to ultrasonic acoustic energy in the 36 to 44-kc bandwidth and a battery-powered 9-lb. instrument which translates the energy into the audio ranges. The device is known as the Delcon ultrasonic translator detector, manufactured by the Delcon Div. of Hewlett-Packard Co. Litton engineers claim the device has proven accurate on all components reaching gyroscope assembly which subsequently have been subjected to extensive run-in evaluation.

U.K. to Use IDCSP for Strat/Tac Communications

Selected British Royal Navy ship and shore facilities will be equipped with 6-ft. dish antennas and necessary electronics for establishment of experimental tactical and strategic communication systems using the U.S. Initial Defense Communication Satellite Program, according to U.K. news sources. Terminals are now under development by the Signals Research and Development Establishment (SRDE) at Christchurch, which confirmed the existence of the ambitious program. Three 40-ft. dish terminals, being developed for SRDE by Marconi Co., will be installed near Christchurch and at undisclosed locations in the Middle and Far East (possibly Aden and Singapore).

Los Angeles Turns to Computers

Advanced computer techniques will be used by the Los Angeles city planning department to prepare a comprehensive growth plan. System Development Corp. will develop mathematical models to determine the relations among residential, industrial, commercial, transportation and recreational activities. In addition, SDC will apply systems analysis and information sciences to the problem, starting with a study of a residential location model developed by the University of Pennsylvania.

OPTICS

Boeing to Get New Research Camera

A camera designed to provide stop-action and continuous streak pictures of materials being explosively destroyed or subjected to heavy shock waves will be delivered to the Boeing Co. by Barr & Stroud, Ltd., Scotland. The camera system, weighing less than 400 lbs., uses standard 120 film with exposure index of about 200 and takes 28 stop-action frames within 20 microsecs. In streak mode, it records particle motion over the same time span, but splits that time into periods as short as 15 nanosecs. A standard lens directs the image to a mirror rotated by compressed air at 5,500 rps—about as fast as a mirror can be rotated without surface distortion.

MATERIALS

Rapid Site Materials Find Other Uses

Liquid resin preparations developed for rapid landing site construction may be used to install telephone poles in certain sandy areas of Vietnam. Two Air Force Aero Propulsion Laboratory engineers suggested the solution after touring Vietnam to investigate materials and techniques to solve problems of instant landing site preparation, soil stability and dust suppression. Half-inch-thick landing pads of resin and glass fibers have withstood jet afterburner blasts of more than 3,000°F.

SPACE MEDICINE

G Tolerance Not Dependent on Conditioning

The spacecrew member in top physical condition may not necessarily be in better shape to withstand high-g forces of launch than his unexercised counterpart, a recent Air Force test has revealed. In a study at Lackland AFB, Tex., 11 subjects were divided into two groups of six exercisers and five controls who avoided vigorous exercise. While significant differences were noted in endurance capacity of the exercisers versus the controls, no difference was evidenced in their ability to withstand positive g's during either gradual or rapid onset centrifuge runs.

AR Tests High Carbon Dioxide Levels

A 15-day test to evaluate the effects of an increased percentage of carbon dioxide, such as that which might occur during an emergency in an orbital spacecraft, has been carried out by the Air Force School of Aerospace Medicine. Four volunteer airmen spent five days in an atmosphere which contained 3% carbon dioxide, or almost 100 times the amount found in normal air at ground conditions. Results are now being analyzed from the test, in which the men did no physical exercise and had daily samples of body fluids taken.

Quest for Martian Life Re-emphasized

ANAHEIM, CALIF.—U.S. scientists have again underscored the importance of trying to detect life forms on Mars despite persuasive evidence that the planet's environment would not foster development of highly evolved creatures.

Support for the continued effort was voiced here at the May 23-25 symposium of the American Astronautical Society entitled "The Search for Extraterrestrial Life."

Dr. Norman H. Horowitz, chief of the Jet Propulsion Laboratory's bioscience section and professor of biology at California Institute of Technology, told the meeting that no matter how bleak the outlook for Mars, the U.S. space program should explore the possibilities of life there to the fullest because that planet appears to be the most likely for life beyond Earth, and *Mariner 4* proved the U.S. has the technology to explore it.

Numerous as the design approaches may be for a *Voyager*-class lander, experts seemed to agree that it will probably be a completely separable aeroshell/lander design with a mechanical means of vehicle orientation/deployment, having a mechanically and electrically connected technique for sensor erection/deployment and employing an event control, preprogrammed approach with command override capability.

Mars landers—Until the exact payload requirements are established, however, no single orientation/deployment system can be selected. Pitt G. Thome and Ernest J. Merz reported on four varied systems that General Electric Co. is working on—the torus, clamshell, petal and folding-legs configurations.

The torus configuration is one of the simplest, but is relatively passive and best suited to landers demanding a minimum of complexity. The clamshell is also relatively simple and free from the need for sequential experiment operations, with most equipment located within halves of the clamshell, and seems most suitable for a complex lander or stationary automated biological laboratory (ABL), according to the investigators.

The petal configuration (probably used in the Soviet *Luna 9*), with petals operated individually for leveling and thermal control, appears ideal for a complex lander or stationary Automated Biological Laboratory. The folding legs configuration is similar to petal configuration but provides better load path for impact survival and can be used for complex landers.

Carlos de Moraes and Robert Scarborough of the Martin Co. visualized the search of Mars as a minimum six-mission endeavor, with all survivable landers designed from the same approach, so that engineering development need be undertaken only once. They pointed out a lifting entry technology, such as that being developed by NASA and the Air Force, could accommodate a large increase in payload weight for roving vehicles as well as an ABL.

Landing site selection will be based on mission and vehicle performance requirements, such as payload, launch window, visibility of critical phases, proper lighting for photographic mapping and direct-link communications requirements, according to Walter E. Tengelson and Joseph P. Duda from Grumman Aircraft Engineering Corp.

They also said experiment-to-vehicle compatibility and experiment-to-experiment compatibility would enter into the decision, as would such things as "buckshot" philosophy (limited data of the same kind being collected from a great variety of locations) and "inkblot" philosophy (consolidation of data status at or near first landing site).

John J. Mahoney, Avco Corp., told delegates that the rate of data transmission is determined by effective radiated power (ERP), which is directly proportional to power of the transmitter and square of the antenna diameter. By using a 20-watt transmitter and a 3-ft.,-dia. antenna, an ERP of 5,000 watts will allow nearly 10^9 bits of data to be returned to Earth in five months, using only direct link. However, he said only the relay method, involving the flight spacecraft, will effectively accomplish communication during entry and descent through the atmosphere.

The relay system will also provide backup support for the direct link after a landing. Magnetic tape (despite problems caused by sterilization requirements) and core storage devices with capacities up to five times 10^7 bits will be used for early soft landers.

Amount of data obtained will be influenced by launch opportunities, with 1973 and 1977 missions probably lasting up to six months. In 1975, trajectory shaping will be required to avoid communications blackout due to occultation by the Sun at or near the time the vehicle arrives in the vicinity of Mars.

JPL samplers—J. L. Stuart of JPL pointed out that even though larger life forms are not found everywhere on Earth, microbiota are present in even the most forbidding areas, therefore the search for life on other planets should first be concerned with these forms.

Stuart discussed three types of sampler systems—atmospheric, surface and subsurface—pointing out the problems involved in these systems in collection, transport, recovery, processing and delivery of samples to the using instruments.

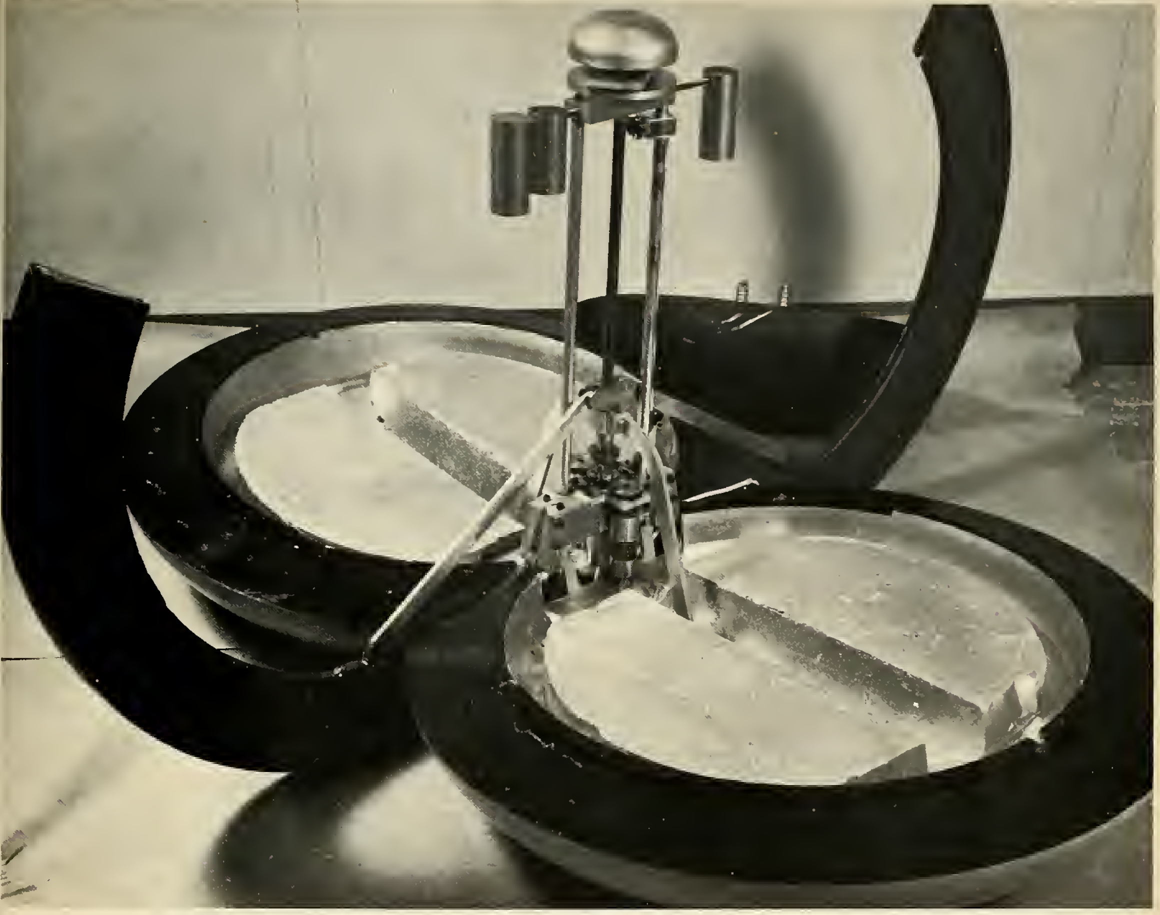
As an example of design considerations, he said studies have shown that the number of viable organisms per unit weight of sampled particulates is inversely proportional to the particulate size, implying that viable organisms are found on the surface of the particulates.

"Therefore, to improve the probability of collecting viable organisms, emphasis should be placed upon the collection of 'dust' rather than pebbles since the surface area of a gram of dust is much more than that of a one-gram pebble."

For atmospheric sampler systems, Stuart said surface winds are an excellent source of bias (toward finding life), because the probability of collecting viable organisms is greater with dust. He described two systems for collecting subsurface samples that are the result of development work at JPL's Space Sciences Div.

These include a simple, hollow, conical drilling device containing holes through which subsoil would be collected, and a self-propelled abrading cylinder sampler with aerosol transport. The latter is powered by pressurized gas and may be made with a minimum of moving parts. Similar to the drilling cone in concept, soil samples would be

Written by West Coast Bureau Chief Willard Wilks and Electronics Editor Rex Pay.



General Electric demonstration model shows how "clamshell" Mars lander capsule might look after beginning operation.

collected through holes and transported to examining instruments under gas pressure through a return hose.

Prototype units of other systems that combine desirable features of various suggested sample collectors are under development at JPL. Stuart said that performance of experiments *in situ* should be considered because of the modifying action of the transfer function involved in sample systems, thereby altering sample character.

Detecting compounds—Dr. Klaus Biemann, Massachusetts Institute of Technology, spoke on the potentialities of the gas chromatograph/mass spectrometer system for detection of organic compounds. He reported that construction of small mass spectrometers of a resolving power for distinguishing integral masses is within the state of the art, and small automated gas chromatographs already have been developed in connection with the *Surveyor* program. Their combination should be possible, he said.

Noting that the large amount of data generated even by a spectrometer of moderate resolving power might tax the telemetry capability over great distances, he said a logical approach would be programmed on-site selection of the most useful portion of the data, or ultimately, automatic interpretation of the data and transmission of the results only. However, the computer capability required would be considerable.

Dr. Gilbert V. Levin, director of the Life Systems Div. of Hazleton Laboratories, Falls Church, Va., reported the firm is working on conceptual development of an integrated life-detection device to seek life on Mars by simultaneous operation of several experiments to detect microbilia metabolism.

The system would serve either as a subsystem in a fully automated biological laboratory, or might serve by itself as a minimum biological capsule. Main experiments incorporated into the system are the Gulliver sticky-string method, based on radiotracer techniques, detection of adenosinetriphosphate by the firefly bioluminescent assay method, detection of photosynthesis and detection of metabolic uptake of phosphorus and sulphur.

In the farther-out realm of seeking to detect intelligent life in other planetary systems, F. D. Drake, Center for Radiophysics and Space Research, Cornell University, pointed out that in the Soviet Union, a group of the most prominent scientists has taken the position that "the detection of extraterrestrial civilizations would be of such profound significance that the expensive search should be undertaken even though success cannot be guaranteed."

Drake said a search having a high probability of success would take about 30 years, requiring the use of at least 100-meter telescopes and associated equipment. Total cost would be about $15 million in capital investment, and perhaps $60 million in operating expenses over the course of the search.

Philco's ABL—Describing the automated biological laboratory studies carried out by Aeronutronic Div., Philco Corp., William Hostetler said that resources within the laboratory were selected for a series of experiments that encompass the most promising primary paths of life detection. The main design concept studied was based on a two-year mission, a seasonal cycle on Mars. A complete experiment cycle would be repeated three times in each of the four seasons.

Total landed weight of the ABL is projected as about 1,200 lbs., which is compatible with the entry capsule size of 6,000-10,000 lbs. planned for 1975-1977. The science payload amounts to 715 lbs., which compares with a little less than 1,200 lbs. for the total weight of the corresponding individual instruments for carrying out the nominal 35 experiments used to establish ABL design parameters.

Data capability of the system amounts to 350 million bits, based on a reliable direct-to-Earth communications link. Two 70-watt radioisotope thermoelectric generators provide power.

Functions are carried out automatically within the ABL in the sequence directed by a scientist who may continuously update his requirements as investigation progresses. The ABL can carry out related or independent investigations simultaneously or sequentially.

Major attributes of life considered in design of the ABL experiments were energy transfer and conversion, macromolecular constituents, reproduction, replication, growth, presence of unique life substances, catalytic activity, and both micro- and macroscopic organization. Two experiment types were selected to measure each of these attributes. A number of environment experiments was also specified.

Its instruments—The major instruments include visual sensing systems, radioactive particle counters, gas chromatographs, UV, visible, and IR spectrophotometers, a fluorimeter, a polarimeter, and a mass spectrometer.

Within the ABL science package, instruments account for 134 lbs., sampling equipment, 86 lbs., and processing equipment, 495 lbs. Of the latter, 25 lbs. are for sample mechanical treatment such as grinding, sizing, and weighing; 278 lbs. are for wet processing, including storage and transfer of materials, and 192 lbs. are for reagents.

Sample acquisition delivers bulk quantities of the Martian surface or subsurface material to the sample processor, where it is graded and delivered to ampules in preset quantities on command. Separate chemical batch operations that are available include preparation of a solution with various selected solvents, extraction, filtering, chemical reactions with various reagents, heating and phase separation.

Equipment is arranged within the ABL so that operations on samples and sample transfer can be available in any combination and in any sequence specified by the spacecraft's control computer.

All equipment is packaged within a nominally spherical payload about 68 in. in diameter, equipped with independently controlled support legs that provide leveling on various surface slopes. A visual survey mast extends to about 16 ft. above the surface and also serves as an anchor for cables used to deploy a remote sampler.

Four different sampling systems are included. One, under the ABL, drills as deep at 10 ft. A second sampler on an articulated linkage obtains samples down to a few inches close to the ABL. Remote samplers are carried along guy wires deployed out to 1,000 ft. by means of projecticles. The fourth sampler is an extendable boom for collecting airborne matter.

The communications system uses an 80-watt transmitter with a 16-db phased-array antenna that has a fan-shaped beam in the ecliptic plane. About three hours of transmission per day are planned, with data rates varying between 20 bits/sec. and 100 bits/sec., according to the distance from Earth.

Automated biologist—Work at MIT Instrumentation Laboratory is directed more toward development of an automated biologist than an automatic biological laboratory. The aim is a system able to concentrate on visual points of interest and to select its own strategy of investigation.

Three development efforts support this goal—design of a layered processor like that in a frog's retina, design of a stereoscopic system that might be used to search a scene, and design of a decision and control system that would function like an animal's reticular formation. This last would decide where a robot on Mars should move, when it should perform each of its experiments, and what it should report.

"Can this be done in time for a Mars landing in the 1970's?" asked Louis L. Sutro, after he had described the aims of the MIT work. "The only way to find out is to try," he said, adding later, "as we enter into the field of layered processing of information we are in strange territory. There is no mathematical theory of nonlinear integral transforms. There is no theory for handling purely informational as opposed to power feedback. . . . Thus we have no recourse but to start simulating and trying before we adduce general design principles."

A model of the reticular formation developed by Warren S. McCulloch and W. L. Kilmer has recently been successfully simulated on a computer and work is concentrating on the functional design of a considerably more sophisticated model.

In the visual processor area, effort is being concentrated on use of integrated circuit elements with arrays of 200 by 200 phototransistors, developed by Westinghouse. The array occupies about one square inch. These would be used essentially in processors that would indicate the presence of an object that was moving (a bug) or that had some other visual attribute. That is, a device for a very flexible form of data reduction would be produced. ■

Douglas Uprating Thor for Air Force

Long-Tank Thor, 22 of which have been purchased by Air Force System Command's Space Systems Div., is in right foreground, with standard Thor booster at left on production line at Douglas Missile & Space Systems Div.'s Santa Monica, Calif., facility. New Thor can lift payloads 20% heavier than the standard booster. At 70 ft., the new version exceeds the old by 14 ft. Long-Tank Thor is cylindrical, while its predecessor, which will continue in service, is conical at top.

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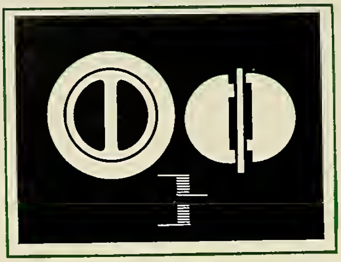

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High Energy for Space: A report from General Dynamics

How can you add calories and not gain weight?

The question, only rueful to waistline worriers, is vital to space flight. Calories are energy that has to be unlocked from fuel. The fuels that now lift relatively large payloads into earth orbit are not really efficient to take them all the way to the moon. Something with more "calories" to the ounce is needed.

The theoretical answer has been known for years—hydrogen.

Hydrogen contains more heat units to the pound than any carbon-derived power source. It burns explosively when mixed with oxygen. Under proper control, it would be ideal.

Enigmas of ultra-cold:

Hydrogen, existing naturally as a gas, is unnoticeable under everyday conditions. To be used as a practical space fuel, it must be carried in the vehicle as a liquid. In that form it is one of the coldest things in existence, 420° below zero Fahrenheit.

In this world of ultra-cold, most materials become as brittle as thin glass. Should the temperature rise only a few degrees, liquid hydrogen "boils" into a rapidly expanding gas that could burst through a sealed container.

Could liquid hydrogen be contained within a vehicle light enough for space flight? Could it be kept cold enough? Be controlled so precisely that its reaction with oxygen would give exactly the amount of thrust needed?

Today, hydrogen has been tamed. When the National Aeronautics and Space Administration's Surveyor lands on the moon, it will have been put on its way by Centaur, the first space vehicle fueled by high-energy liquid hydrogen.

Centaur was originally started by General Dynamics as a research project for the Department of Defense to test the feasibility of hydrogen as a fuel. Now operational for NASA, Centaur is the most powerful upper-stage space vehicle for its size and weight available. In nature the most efficient container in terms of weight to strength is considered the shell of an egg. Centaur, which needs only 1/35th of a pound of tank for each pound of propellant carried, is three times more efficient.

But before Centaur became operational, major problems had to be solved.

Early hurdles...

On the ground liquid hydrogen must be stored in large stainless steel tanks with double walls filled with insulation and evacuated to a high vacuum. Similar permanent insulation would mean a substantial weight penalty for a space vehicle.

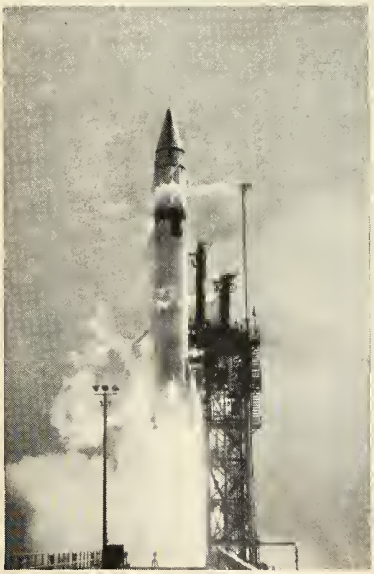
With the best available insulation, relatively high external air temperatures on earth and the friction heat generated during booster flight cause some boil-off, creating the danger of constantly increasing gas pressure inside a tank. Liquid oxygen must be carried in the vehicle to react with the hydrogen. Lox is pretty cold itself at −297° F., but "hot" enough to make hydrogen boil.

Centaur's stainless steel tank, which is also the external skin of the vehicle, is only one-third the thickness of a dime. The extreme cold initially created microscopic cracks, visible only under magnification, in the stainless steel around some welds. Such cracks could cause structural weakness—and leaks, since hydrogen, the smallest of atoms, can seep through openings that will hold back everything else.

...and answers:

For external insulation Centaur is wrapped with 1,200 pounds of inch-thick glass fiber panels filled with plastic foam. Just before the upper stage separates from its booster, the panels, which have served their purpose, are forced away by explosive charges. Now Centaur is free to reach its required speed at a minimum insulation-weight penalty to the mission.

To control boil-off, venting systems bleed off hydrogen gas during propellant loading and until launch at 18 pounds per minute. Excessive pressure is prevented from developing inside the tank, yet the gas is sufficiently diffused that it can be fed into the atmosphere without danger of explosion. During booster flight, venting continues until the vehicle enters the frictionless cold



Atlas-Centaur launches a payload.

How Centaur works as a space vehicle

Space flight requires both muscle and speed. Whether the payload is a grapefruit-sized satellite or a manned capsule, it must be pushed to a speed of 25,300 feet per second to reach a 160-mile high orbit around the earth. To go to the moon, it must hit 36,000 f.p.s.

The muscle is supplied by a launch vehicle whose initial push, defined in pounds of thrust, must be sufficiently greater than the total weight of the vehicle, fuel and payload to overcome the pull of gravity.

The heavier the combination, the more thrust is needed to get it started against the pull of gravity and to keep it moving fast enough to reach its destination.

Just adding more propellant to a single stage vehicle would ultimately make the propellant containers so heavy that the vehicle could not reach the necessary velocity.

So for speed, a second stage is used.

This tandem combination can be compared to a sports car being pushed by a truck. The truck goes as far and as fast as it can. When both vehicles reach the top speed of the truck, the fully fueled sports car starts, adding its own acceleration to carry its driver farther and faster.

Centaur's "truck" so far has been an Atlas, the same General Dynamics' launch vehicle that boosted the first American astronauts into orbit.

Fully fueled on the ground, Atlas, Centaur and a two-ton payload weigh a total 303,000 pounds. Atlas' 380,000 pounds of thrust, provided by a kerosene-derived fuel, push the combined vehicles to 91 miles and a speed of 12,700 f.p.s. before it drops off and Centaur's hydrogen fueled engines take over.

The high energy of the smaller Centaur now need push only the 36,500 pounds of itself and the payload against less gravitational effect and without the resistance of the atmosphere. After 440 seconds of firing, Centaur is traveling at 36,000 f.p.s., fast enough to send its payload along its orbit to the moon.

of space, when the bleed drops to a half-pound per minute.

One step in the elimination of microcracks was to thicken the original skin of Centaur a bare .004 inch to its current .014 inch. To reduce them further, all the vehicle's 162,000 spot-welds are X-ray inspected, and any imperfect welds are repaired before assembly continues.

Extra chores:

In addition to its fuel energy, the hydrogen even helps itself work.

The ultra-cold actually solves one insulation problem. Oxygen and hydrogen tanks are separated by less than one-third of an inch, but the liquid hydrogen freezes air between the tanks into a solid, creating a narrow vacuum that minimizes the passage of heat.

The thrust chamber—where the fuel is burned—develops temperatures of some 5,500° F. Such heat could quickly bring the cryogenic propellants to the explosion point.

On its way to be "burned," liquid hydrogen is first pumped through a cooling jacket surrounding the thrust chamber, separating the very hot from the very cold areas.

In absorbing the engine heat the liquid expands to a turbulent gas to be used for the energy reaction. But some is temporarily diverted to drive turbopumps that feed the propellants in required amounts to the engines. Without this technique, propellants would have to be force-fed to the engines under high gas pressure, requiring thicker tank walls and greater weight.

Slimming down more:

Centaur, for its size, is the most efficient single vehicle in operation today. Its fuel is the most efficient currently available for space use.

Yet further improvements are being worked on by General Dynamics: metals equally strong and possibly lighter; "super-insulations"; uprated engines, advanced control systems and fuel additives to increase performance.

As Centaur matures, it's going to take on even more calories—and probably lose more weight in the process.

General Dynamics is a company of scientists, engineers and skilled workers whose interests cover every major field of technology, and who produce: aircraft; marine, space and missile systems; tactical support equipment; nuclear, electronic, and communication systems; machinery; building supplies; coal, gases.

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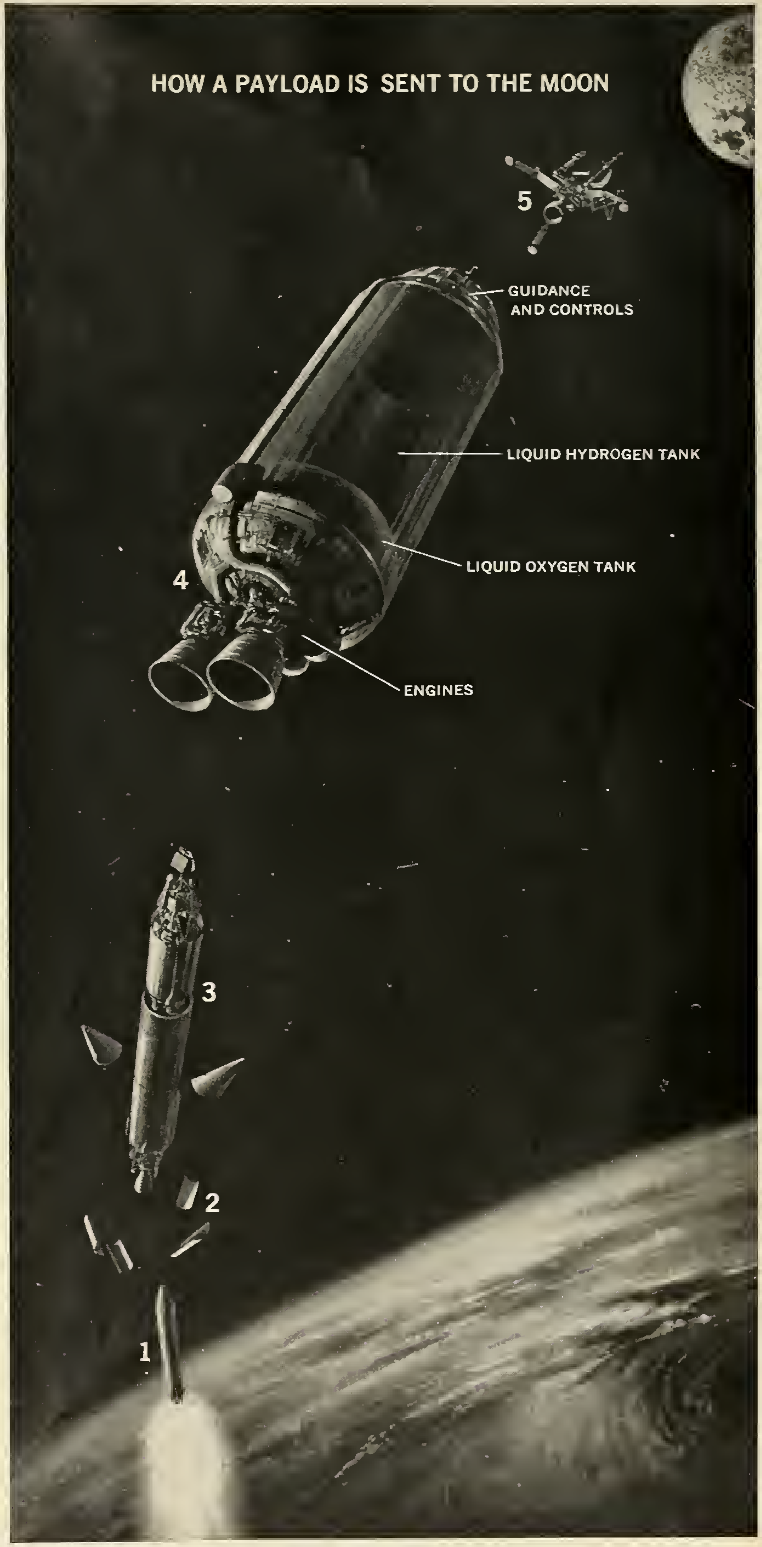


1—Atlas starts Centaur and its payload on their flight. **2**—Shortly before Atlas and Centaur have separated, insulation panels and then nose fairings have been jettisoned. **3**—Atlas separates and Centaur and payload start their phase of journey. **4**—Centaur has completed firing and separated from payload. **5**—Payload continues along its orbit to the moon.

Health Prediction During Orbit Studied

Los Angeles—Some 2,000 individuals are helping in a program here which may lead to a method of precise prediction of astronaut health in orbit through biomedical monitoring.

Involved are members of the Retail Clerks Local 770 and Food Employees Benefit Fund in Hollywood, which has contracted with Beckman Instruments, Inc., to set up an intensive program of biomedical monitoring. With the aid of computers, the program will result in diagnoses with an exact numerical evaluation of each person's susceptibility to illness.

A corollary effort in Beckman's advanced research department is development of a means of predicting space crew proneness to organic disease or adverse effects of the environment.

Heading the team at Beckman is Dr. Tom Weber, manager of the advanced research department, and Arvo Schoen, who is responsible for program planning, definition and operational control.

The concept is based upon the realization that the signless, symptomless human body will undergo many small changes—none of which signal an organic disease or susceptibility *per se*—long before the onset of trouble.

For instance, within one individual, certain elements of the blood may increase or decrease in number, though well within normal parameters. Metabolic response to exercise may change slightly—again within population norms. However, together with personal history, such changes within one individual may spell a fatal heart attack or other serious trouble within months.

Only by extensive periodic examination, in which large numbers of measurements are taken and each individual is compared with his own record, can the true picture emerge, Beckman scientists said.

The work in part grew out of Beckman's involvement in the Biolabs program, for which Lockheed Aircraft Corp.'s bioastronautics department was prime contractor to NASA. Beckman developed a conceptual system for biochemical and hematological analyses in space, including zero-g coupling mechanisms for fluid handling, and the conceptual adaptation of clinical devices for biomedical measurements in space.

The company completed a study of biomedical monitoring for the *Manned Orbiting Laboratory (MOL)* and made recommendations to the Air Force.

With longer flights such as in the *MOL* and *Apollo* Applications forthcoming, the company feels that monitoring must take on a new dimension—that of predicting future health conditions in time to change the patterns leading to trouble.

In addition, the state of the astronaut's body reserves and defenses must be continually known to be able to cope with emergencies or stresses such as reentry.

Ground-based program—The whole battery of tests being formulated for the clerks union will be repeated on each of the more than 2,000 employees twice each year. About 400 to 500 parameters will be taken on each individual, Schoen told Technology Week. These include biochemical and hematological analyses, clinical measurements of the respiratory, neurological, gastrointestinal and cardiovascular systems, anthropomorphic measurements such as muscle and bone sizes and weights, height and weight ratios, and new measurements such as parotid secretion analysis.

New tests and techniques will be phased in as they are developed. For instance, while the conventional electrocardiogram is planned for the present, Beckman plans to modify the method to obtain a digital reading which will enumerate about eight or nine parameters.

Functional measurements—that is, measurements of various systems as they perform under work loads and stress—will be of special importance.

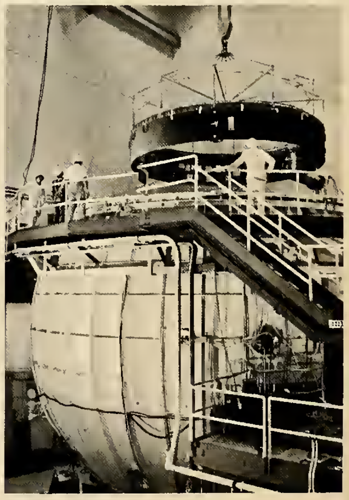
These will obviate confusion from individual variances because of tests being taken at different times in the day, Weber said.

All measurements will be combined with historical information and environmental data. The results should show susceptibility to organic diseases, in numbers, and the degree of body reserves. Therapeutic measures could then be taken.

Data could amount to as much as 1,000 bits per person, and will initially be handled on an IBM 360 computer. Some 22 to 24 people, mostly technicians under the direction of a physician, physiologist, systems engineer and biostatistician, will conduct the union program. Each examination is expected to take 2½ hours.

The program has special significance, Beckman scientists pointed out, when recent data estimate that about 10% of the so-called healthy population

Saturn Instrument Unit Undergoes Lunar Testing



The instrument unit for NASA's Saturn/Apollo launch vehicle is lowered into a space simulation chamber at Douglas Aircraft Co. The unit, along with a simulated forward section of the Saturn S-IVB rocket and a dummy lower portion of the Apollo assembly, will undergo environmental testing in conditions typical of those which will be encountered during flights to the Moon. Seven tests will be conducted under a $2.7-million contract.

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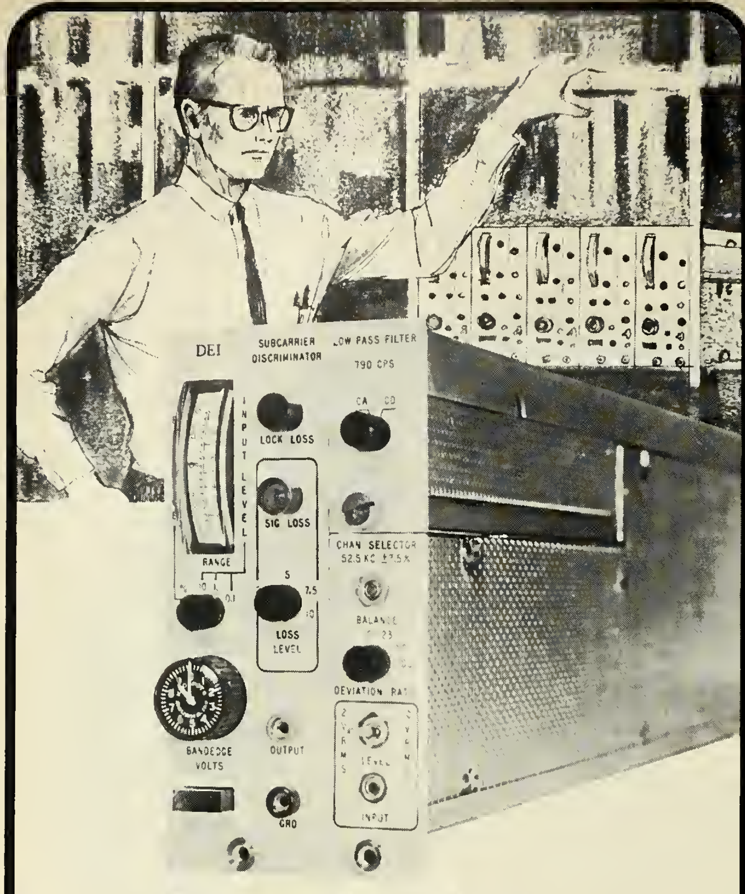

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already has a hidden illness and an additional 80%, if examined closely, would show signs of impending problems.

Spaceflight system—The addition of the unusual environment of space adds another dimension to the problem. "Reconditioning" of the body systems because of the added variable of weightlessness probably will occur. This would not show up in the operation and functional capability of the astronaut.

Yet, the astronaut must be in better condition than the average person if he is to withstand the forces of re-entry and return to 1 g. Thus, a close watch must be kept on his basic adaptive mechanisms, the scientists said. This ability to adapt must be controlled, in order that he can re-adapt to the Earth environment.

The second important function of biomedical monitoring must be to predict the effects of the space environment during extended-duration missions. This must be based on a determination of the body system's reserve remaining and degree of susceptibility to stress.

Body system reserve, Beckman scientists said, can be established by observing rate changes in normal and regulated body functions when exposed to varying conditions.

Body systems which could be monitored significantly in this fashion, the company said, would be the hepatic, renal, endocrine and hematopoietic systems. All major metabolic pathways and stress countermeasures of the body are generated, regulated and maintained by these body systems.

The inherent defense capabilities of the body also have a bearing on body systems susceptibility to stress, they said. General measurements of globulin levels, evaluation of the varying picture of the leucocytic system, determination of the phagocytic capabilities of the leucocytes, indentification of the clotting mechanism status and changes in the microbial flora of the body would aid in giving an index of body ecology in space.

Weightlessness unknowns—The short term-mission data thus far collected does not yet answer the question of whether the minimal changes which have occurred will not progressively worsen during long missions. Thus, Beckman scientists pointed out that careful attention must be focused upon the high-risk metabolic and functional parameters.

Thus far, the elevation of serum calcium and depression of blood glucose are generally accepted as being signals to the greatest threat areas. It is not known, however, whether these changes are decrements or general adaptations,

(Continued on p. 38)

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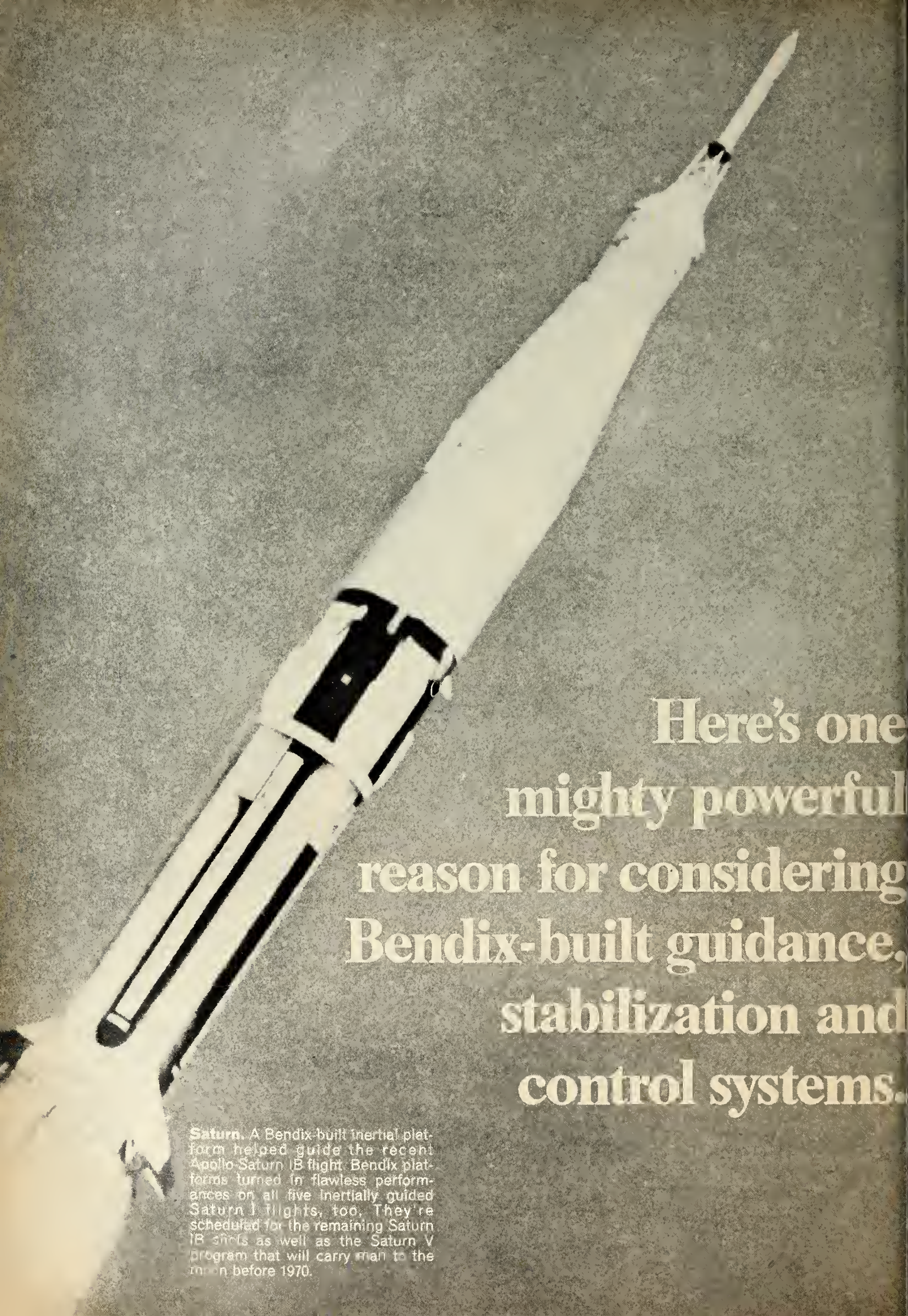

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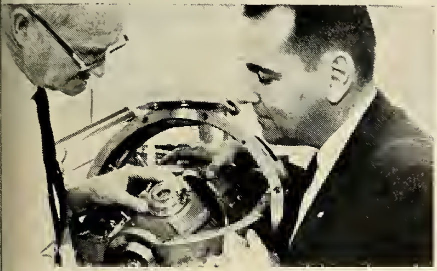

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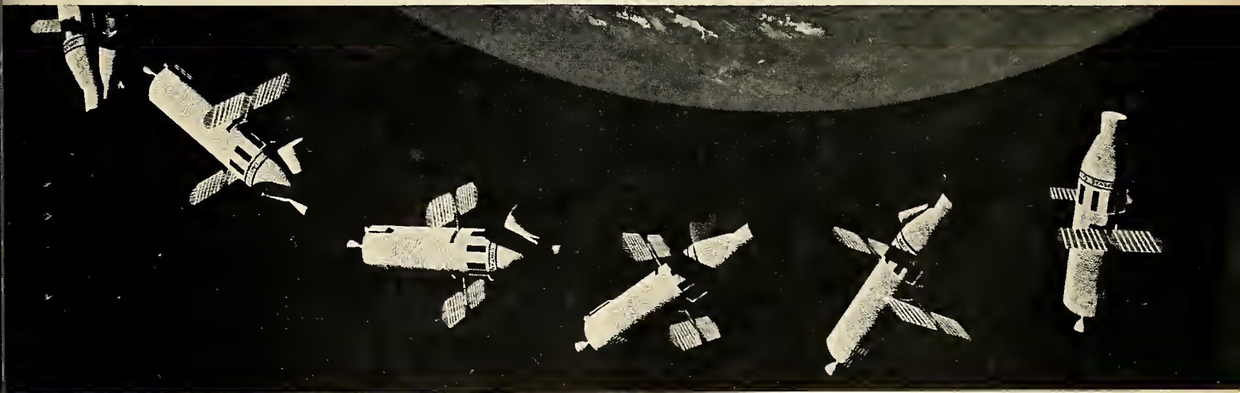

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and if the latter, what threat they may pose to the astronaut during re-entry.

Simply taking such measurements, such as blood glucose levels, would not by itself give enough information to assess adaptive processes, since these levels can vary greatly during any period of time, especially during stress.

Beckman believes that only by developing a standardized and reproducible stressor, which would be used to challenge and elicit a response profile for the adaptive mechansims, can the true picture be drawn.

With such a response, the current status of the functional mechanism of the body system could be ascertained along with the basic energy level of the system. This could be repeated at a later interval, and by comparison of profiles, a rate of decrement can be established.

This would provide the capability for anticipating serious decrements, providing time limits within which counteraction and prevention must be provided.

Because of the many unknowns involved in spaceflight, all possible changes cannot yet be determined. Thus, changes in diurnal rhythms and body systems cycles in general, when taken from the individual astronaut, will provide highly predictive information.

The problem Beckman scientists stress is to separate the merely adaptive responses to those which are caused by maladaptation and early degeneration. Backup testing will isolate and diagnose the primarily maladaptive responses.

Methods of monitoring—Much has been said about the kinds of tests which should be performed to get an adequate picture of the astronaut's body defenses. However, many have required the taking of blood samples from the astronauts at periodic intervals.

Beckman scientists suggest that a better approach would be to use those body fluids which are normally discharged or lost to the body, such as tears, sweat, saliva and urine. Blood studies could then test essentials.

A wafer-type collection and measurement cup which measures parotid flow—the secretion in the saliva which comes from the gland below the ear—and performs a number of analyses on line has been developed at Beckman. Information from the unit can be telemetered to the vehicle and introduced into the data-management system.

Parameters which could be measured in a schedule showing diurnal cycles would be glucose tolerance, fat tolerance, serum proteins, albumin, globulin ratio, BUN, calcium, sodium, potassium, and BSP excretion.

Urinary measurements of pH, proteins and glomerular filtration rate by some specific compound also would be essential.

Some blood studies would be necessary, Beckman scientists said. Those which would measure function would include the white blood cell motility and phagocytic activities, clotting time, bleeding time, partial prothromboplastin time, red blood cell survival and plasma volume changes.

Some static measurements would be added, including hematocrit, total cell counts and differentials, and hemoglobin. An immunochemical separation of the globulin fraction also should be added for body defense system status, they said.

In making conceptual designs of orbital equipment to perform these analyses, the Beckman group worked on the assumption that the astronauts would be performing the essential manipulations manually. This was done to provide flexibility for increasing the scope of the monitoring program, reducing equipment requirements for automation, and minimizing the development time to generate new instrumentation techniques.

Thus, the design of the reliable, non-automated sample manipulation system is based on the syringe principle, they said. Valving and porting devices were designed and incorporated at various locations so that various reagents could be added, removed, mixed, or reacted before chemical readout.

Various types of electrodes, for instance, can be inserted to the plunger part of the syringe for direct measurements. A sonic mixer can be attached to the wall of the device if needed.

Prepackaged reagents could be utilized with the use of syringes with multicompartment plungers. Various heads could be mounted on the syringes for filtration and separation of the sample.

Beckman has stressed the importance of the development of the coupling and valving mechanism used to transfer liquid samples in zero-g.

In addition, the company has designed a chemistry station for storage of reagents other than those prepackaged within the manipulating device, and for sensors and their electronic components.

The station panel also features a centrifuge for use in biochemical analyses and work area for monitoring functions. Data could be introduced manually as well as automatically by means of a coded keypunch.

Data could either be dumped to the ground or handled by an onboard computer which could match the monitored information and establish profiles relating to status condition.

The larger the degree of variance from the signless, symptomless profile, the scientists pointed out, the more urgent the need to initiate remedial and preventive measures. ■

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CIRCUIT DESIGN ENGINEERS
Responsible for solid state circuit design—servo amplifiers, power supplies and telemetry conditioning circuits for inertial systems. Circuits are for highest reliability applications and worst case analyses are required as well as confirming test evaluation.

CONTROL DESIGN ENGINEERS
Responsible for creating new design approaches in packaging solid state electronic circuits, particularly miniaturized potted modules utilizing integrated printed circuits and for over-all assemblies of such components. Also responsible for providing product drawings for production items and supplying technical support for production items and supplying technical support to the manufacturing facility.

INERTIAL GUIDANCE ENGINEERS
Responsible for the test and evaluation of gyros and accelerometers for inertial systems. Must have a thorough working knowledge of gyro test equipment and methods to permit the design of special test to determine suitability of gyros and accelerometers for specific and unusual applications. Must be able to prepare and negotiate technical specifications for inertial subsystems with customers.

INERTIAL GUIDANCE SYSTEMS DESIGN ENGINEERS
Responsible for conducting systems design studies with special emphasis on guidance system accuracy and design compatibility with fire control and missile equipments. Guidance system parameter and system test requirement definitions are required. The work requires significant experience in military electronic systems with emphasis on inertial devices, servos, and digital computers.

INERTIAL GUIDANCE ENGINEERS
Responsible for selection and application of gyros and accelerometers for inertial systems. Good fundamental knowledge of gyro principles and terminology, test methods and equipment, and so forth, is required. Should be able to generate meaningful procurement specifications and support purchasing in the technical portions of negotiations.

INERTIAL GUIDANCE SYSTEMS EVALUATION ENGINEERS
Responsible for developing inertial systems evaluation techniques. Contribute directly to the evaluation of the first few of a new system design, isolating design or compatibility problems. Contribute to flight test program, analyzing guidance system performance data. The work requires significant experience in military electronic systems with emphasis on inertial devices, servos and digital computers.

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ELDO Nations Consider Body's Future

by William S. Beller

Paris—The recent suborbital flight of *Europa I*, termed a success by European Launcher Development Organization (ELDO) officials, will contribute most heavily to the considerations of the science ministers of ELDO countries coming here June 9 to decide the fate of the launcher organization, and thus the direction of the major thrust of space work in Europe.

The June 9 meeting is a continuation of the three-day session held here late in April at which France answered England's pessimism about the future of ELDO with studies showing a vastly increased capability for an augmented *Europa* launch vehicle. It would be able to lift a 200-kg communications satellite into a geostationary orbit.

The augmented *Europa I* would be given a fourth stage derived from the third stage of France's launcher *Diamant*, which put the first French satellite, *A-1*, into orbit last November from the Hammoguir range in Algeria.

Specifically, the fourth stage would contain about 750 kilograms of solid propellant for a perigee kick, plus 100-125 kilograms of structure. Moreover, like *Early Bird*, the new *Europa I* satellite would have an apogee kick motor.

Europa background—The basic *Europa I* is a three-stage rocket made up of the United Kingdom's *Blue Streak*, France's *Coralie* and an unnamed German third stage. Besides the three nations contributing stages to the rocket, the members of ELDO are Belgium, the Netherlands and Australia for its launch site.

Since its development began under ELDO sponsorship two years ago, *Europa I* has gained in estimated cost and lost in estimated payload.

The original estimate was for less than $200 million, and now it is $425 million, plus possibly another $60 million if the augmented *Europa I* space vehicle and satellite are approved.

The ministers also learned at the April meeting that the 200-kg comsat would require a near-equatorial launch. This ruled out Woomera, to the United Kingdom's distress, and boosted the stock of the new French Guiana site, which the French are eager to use, particularly after spending so much money developing it. French Guiana is only four to five degrees from the equator.

Other proposed sites include one in northern Australia near Darwin, and Italy's San Marco platform in the Indian Ocean.

The possibilities opened by the augmented *Europa I*, a surprise to many of the ministers at the April meeting, plus the impending British elections, caused those attending the meeting to delay its adjournment and final meetings until next month.

Thus, the biggest space questions in Europe are, will the U.K. stay in ELDO, and what happens if she withdraws? The psychological boost the launch of *Europa I* has given proponents of Britain's staying in the organization cannot be overestimated.

The questions are so tender politically—because they are tied in not only with major space policy but also with the U.K.'s position as a communications center and Britain's aim to join the Common Market—that responsible officials are reluctant to talk for attribution. Nevertheless, a series of Technology Week interviews in Europe resulted in the following background information.

Europa I, powered by Britain's Blue Streak, begins flight from Woomera, Australia.

A political ploy?—England, unhappy at the rising costs of ELDO, especially since the costs of her *Blue Streak* booster have not appreciably risen, may be threatening to pull out of ELDO to relieve herself of major financial support of the organization. The present scale of contributions calls for the U.K. to give 39%, France 24%, Germany 22%, and the remainder divided among the other members.

France is already unofficially conceding she would be willing to contribute more, and that an equal burden of 23-28% of the cost of running ELDO might be a fair share for herself, the U.K. and West Germany to bear. But the U.K. will have a more difficult time trying to persuade France and other ELDO countries to continue to accept Woomera as the comsat launch site.

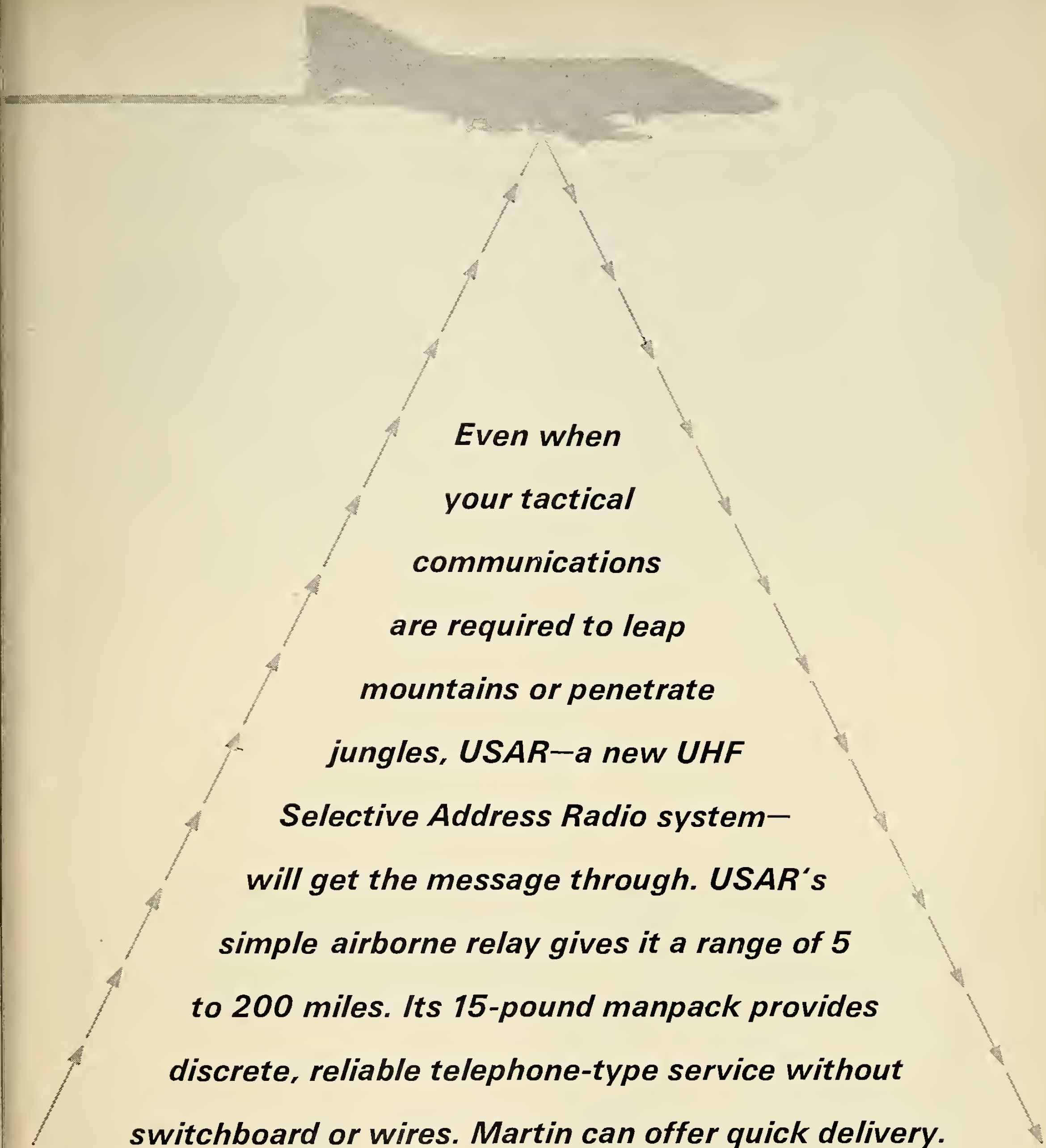
The economy-at-any-cost segment in British government could still win out and take the U.K. out of ELDO and thus out of commercial space work for many years to come.

Lure of comsats—Europe now has a space goal within its technological grasp, and a rallying cry to unite the ELDO countries to attain the goal. When the day of direct telecasts to home receivers arrives, "we want the voice of Europe to join in the chorus with the voice of America and voice of Russia," said a German official.

The strong note for Europe having comsats of its own was struck this past March in a Eurospace report stressing the urgent need for such satellites "to safeguard the essential interests of the European nations."

The report said no aid could be expected from NASA in this endeavor and consequently European nations must "decide immediately on the joint development of a satellite television broadcast system so that the interested countries would form a group which could become a full partner in this balance of future world interests."

The Eurospace report was given substance at the April ELDO meeting when the augmented *Europa I* was suggested. ■



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Surveyor Mission Rigidly Controlled

PASADENA, CALIF.—The *Surveyor* spacecraft represents a major change in spacecraft operation philosophy at Jet Propulsion Laboratory. It is under tight control from the ground, receiving commands every 0.5 sec.

Many of these are "fill-in" commands of no significance, but during the nominal transit, some 280 real commands will be sent. This compares with 11 commands sent to *Ranger 8*.

On *Ranger* and *Mariner* spacecraft, a command acted as a key that set in motion onboard programmed activities. These spacecraft virtually flew under internal control.

The only parts of *Surveyor's* entire flight sequence that do not normally require direct Earth control are certain phases of attitude stabilization, terminal descent, and solar panel deployment. And even these have backup Earth commands.

There are 250 mission-dependent personnel involved in the *Surveyor* mission operations system (MOS), plus regular personnel in segments of the MOS such as the deep space stations (DSS) and the space flight operations facility (SFOF). There is also a considerable amount of mission-dependent equipment at these locations.

"We are the first project that is really using the SFOF to its total capability," Dr. Theodore F. Gautschi, Mission Operations System director for *Surveyor,* told TECHNOLOGY WEEK.

Command system—Commands that turn equipment on or off or select telemetry modes are called direct commands. There are also 1,024 quantitative commands that determine such things as the duration of the thrust exerted by *Surveyor's* attitude-control jets or vernier engines.

As an example of the flexibility provided by the command system, the planar array antenna and the solar panel can be locked and unlocked and adjusted in all three axes in increments of 0.125 degree. The four commutators that sample more than 200 engineering measurements can be commanded into operation at any time and at any of five bit rates: 17.2, 137.5, 550, 1,100, and 4,400 bits/sec.

The spacecraft's command subsystem employs two identical receivers, each connected to an omnidirectional antenna. A receiver/decoder selector couples the two receivers to two central command decoders. Only one receiver and decoder are used at one time. It is the function of the selector to decide which of four possible combinations is brought into use. A change in combination is made when the command signal transmitted from Earth is interrupted for at least 0.5 sec. That is, if no command word or fill-in word is received by the spacecraft, a new receiver-decoder combination is automatically selected.

The outputs from the active central command decoder pass to as many as 32 subsystem command decoders.

The command arrives at the spacecraft in the form of a 24-pulse wavetrain. The central decoder subjects direct commands to a complement check on both the address and command bits before passing them to the correct subsystem decoder. If the complement fails to check, a reject signal is telemetered back to Earth. If it does check, a command-enable signal is transmitted. Fill-in words do not complement check and are rejected.

When a quantitative command arrives, a complement check is made on the address only. The magnitude bits are telemetered to Earth for verification.

Focal point—The central point for Earth control during the mission is the mission control room on the first floor of the space flight operations facility. Two communication and control consoles provide voice contact with any DSIF station and any of the other operation areas in the SFOF. Two closed-circuit television monitors in each console can display pictures from any of 60 television cameras in the SFOF as well as real-time television pictures taken after lunar landing.

Voice, teletype and high-speed data lines connect each DSIF station to the SFOF. The voice and teletype lines are two-way. The high-speed data links carry significant portions of the spacecraft telemetry to the SFOF in real time. Goldstone can transmit data to SFOF at 4,400 bits/sec., and Johannesburg at 550 bits/sec. Teletype communications to all stations are at 6.1 characters per sec. Goldstone can also transmit spacecraft video directly to the SFOF.

The requirements put on the command communications links between the SFOF and deep-space stations around the world are greatly reduced by the installation of an on-site data processor and a command and data-handling console (CDC) at the various ground stations.

Relatively simple requests for a preset sequence of commands can be transmitted by voice or teletype to a ground station, and the new equipment will convert them into the complex trains of 24-bit signals that modulate the transmission to the spacecraft.

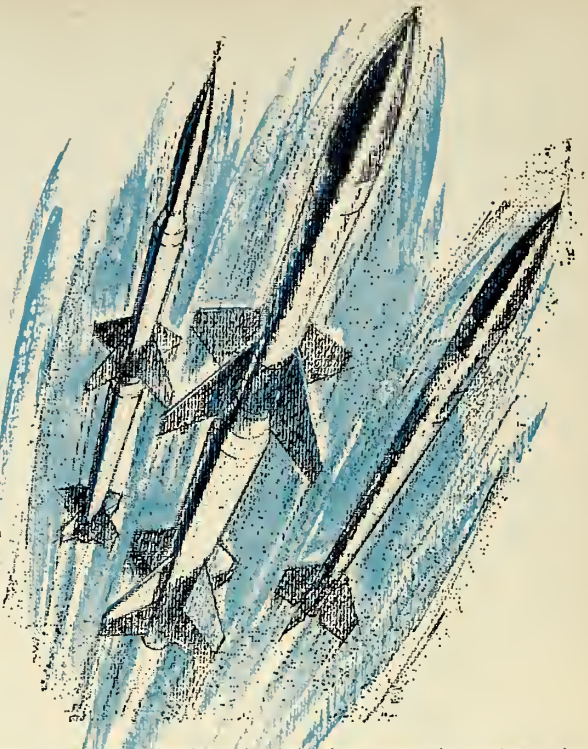
For general use on the ground, the spacecraft commands are converted from the 24-bit binary form to a four-digit number in octal form (using the digits 0 through 7). Commands frequently used in established sequences are grouped in minor or major sequences that can be identified by an octal number. A minor command sequence is made up of one or more individual commands; a major command sequence is made up of one or more minor commands.

Routine mission—On a nominal mission some 1,100 standard sequence events will be initiated in the spacecraft by means of 110 major and 250 minor command sequences. These are made up from a listing of 256 direct commands and 1,024 quantitative commands. The third digit in the standard octal command word indicates the type of command it is. A 4 indicates a major sequence, a 5 indicates a minor sequence, 0 to 3 indicate a direct command or a quantitative command.

Command sequences will usually be stored on punched paper tape at each of the ground stations. When a request for execution of the sequence arrives from SFOF over a voice link, the CDC operator starts the command tape reader in his equipment searching for the individual command or command sequence.

On location, it is displayed in a form that can be read back to the SFOF, which then gives the go-ahead. The on-site data processor routes the executed command by teletype to the SFOF data processing system for real-time display and confirmation.

5 SOUND REASONS to THINK THIOKOL for your sounding-rocket programs



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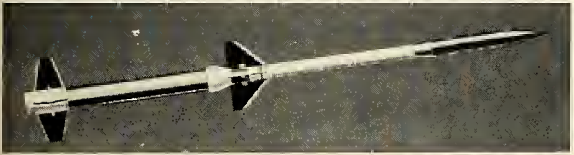
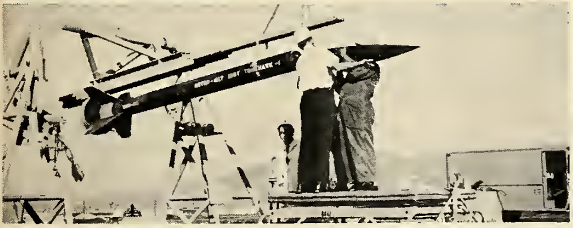
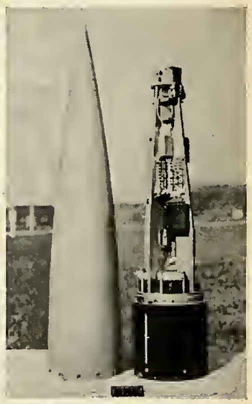


Nike-Tomahawk with 12" Payload



Preparing Single-Stage Tomahawk for Launch

AML-4K3 Rocket Launcher



Astro-Met-Built Sounding-Rocket Telemetry Payload

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Where there are no prepared command tapes for a new command situation, a command message is prepared by means of computed programs at the SFOF and transmitted to the DSS by teletype. There it is received by the on-site data processor, which generates a command tape for the CDC command subsystem. Verification of the new command tape and of the executed commands is carried out by teletype transmission to the SFOF.

It is also possible to use a manual keyboard on the CDC instead of the command tape reader. This is useful when the new sequence is a minor variation of a sequence already prepared on tape.

To confirm correct storage of quantitative commands in the spacecraft, the SFOF receives returning information from the ground stations by teletype or by high-speed data line.

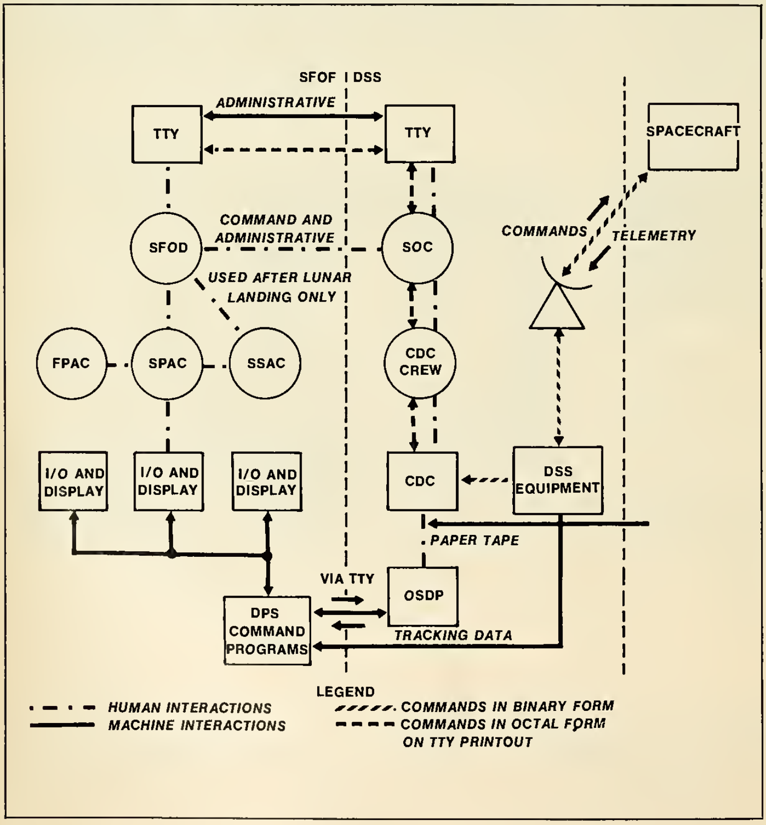
CDC function—At the ground stations the CDC generates FM digital command signals from the punched tape or manual inputs, then prints a permanent record of the commands sent. Up to 1,024 different commands can be accommodated. The FM signal is routed to the station's transmitter.

The CDC equipment also handles incoming data from the spacecraft. It accepts the FM intermediate-frequency signal from the station's receiver and produces a baseband signal consisting of either video data or engineering subcarrier signals.

A TV data subsystem processes the television signal for real-time display at the CDC and at sites other than Goldstone for 35mm recording. Frame identification data is also displayed and recorded. Picture quality can be evaluated by an operator viewing a long-persistence TV monitor in the CDC console.

Separation of the various engineering data channels from the baseband signal is carried out by the telemetry data subsystem of the CDC. Discriminators are provided for each subcarrier channel. Each discriminator output is relayed to the on-site data processor for formatting and transmission to the SFOF. ■

Surveyor command system diagram. Following is a key to abbreviations: SFOD—spaceflight operations director; FPAC—flight path analysis & command group; SPAC—spacecraft performance analysis & command group; SSAC—space science analysis & command group; DPS—data-processing system; TTY—teletype; DSS—deep-space station; SOC—Surveyor operations chief; SFOF—spaceflight operations facility; OSDP—on-site data processor; CDC—command & data-handling system.



Standards for Laser Safety Advocated

By Charles D. LaFond

Orlando, Fla.—A single authority must be established to determine, disseminate, direct and control safety procedures and standards for laser R&D and operation.

This opinion was shared by most of the nation's medical and scientific experts attending the first Laser Safety Seminar, sponsored here May 19-20 by the Martin Co. in cooperation with the U.S. Army Surgeon-General's Office.

The Dept. of Defense has organized a special group on optical masers, responsible for coordinating all military-funded or directed R&D projects, but, seminar panelists asserted, its effort on laser hazards has been negligible.

The problem, they stated, lies with poor intercommunication among the many organizations involved in laser research and laser-hazard studies. These include such diverse groups as the three military services, the Federal Aviation Agency, U.S. Public Health Service, NASA, U.S. industry and a multitude of universities and non-profit research foundations. The National Research Council also is looking into the problem.

With so many limbs independently flailing without benefit of a single head to correlate, analyze, evaluate and share experience, repeated self-injury seems assured.

Already there have been numerous injuries, resulting from ignorance, carelessness or gross stupidity, to personnel working in the lab and in the field with medium- to high-power lasers. Countless others may suffer ultimate injury from long-term or cumulative effects of laser radiation—even with low power systems.

Ocular hazards—Most susceptible to laser-beam damage is the eye. Potential injuries range from temporary flash blindness and minimal retinal lesions to gross retinal lesions resulting in instant and permanent loss of vision.

Such ophthalmic injuries are certainly not new, pointed out Dr. William T. Ham, Jr., biophysics department director at the Medical College of Virginia. Similar and equally disastrous effects have been suffered by persons viewing solar eclipses and nuclear explosions without ophthalmic protection.

Ham's group has pressed an intensive study for the Surgeon General's Office of laser ocular effects on mammals. Using rabbits as subjects and varying the parameters of radiation, such as time, energy, and frequency, he has studied damage thresholds and gross effects.

He found that minimal retinal lesions were produced in rabbits with a 3-min. continuous-wave exposure at 5.8 watts/cm.^{2} (in the 300 to 600-mμ range). A 17.5°C increase in temperature was measured on the retinal area. Similarly, a 30-nanosec. burst, using a neodymium pulsed laser with a power density of 14.6 Mw/cm.^{2} produced a minimal lesion.

Principal direct damage is effected thermally (burns) and photochemically (bleached pigment), Ham reported.

There is a theoretical possibility, Ham disclosed, that repeated direct observation of even low-power laser beams could cause iris damage that secondarily could lead to glaucoma. However, there is presently no statistical proof to support this belief, he said.

It also has been found that electroretinagraph (ERG) ratings obtained from test animals were often significantly lowered following laser exposures from energy levels 50% below the visible-lesion-forming threshold. The effect on humans is not known since ERG measurements to date have been possible only with animals, Dr. Walter J. Geeraets, University of Virginia, told TECHNOLOGY WEEK.

(Moorefields Eye Hospital in London employs ERG's regularly now for ophthalmic-disease diagnosis. The Institute of Ophthalmology there has successfully completed a two-year research effort developing the technique.)

Other effects—In the study of other injurious effects on mammals (nonocular due to laser irradiation, Dr. Edmond Klein of Roswell Park Memorial Institute stated that his group has worked in the lab with over 5,000 test mammals including rats, rabbits, and monkeys.

Much of his work has included use of high-power, pulsed, solid-state lasers and continuous wave gas lasers to study direct and gross radiation effects by single exposure. Considerable emphasis has been on non-linear (non-thermal) secondary effects, he said. These include pressure and shock-wave generation, photosensitizing and photoactivating effects, particulate motion and impact, and optical effects such as frequency multiplication and scattering.

Damage thresholds have been studied, said Dr. Klein, from minimal to extensive internal and external injury. It was found that a pulsed 50-joule-level beam that caused negligible thermal effect on the skin produced marked cerebral damage in rats. Brain hemorrhage was extensive while the skin surface was only slightly burned.

Yet the same 50-joule pulse directed toward a mammal's ankle area caused only minor reversible injury, he disclosed. A 250-joule burst, however, resulted in "spontaneous amputation with almost no hemorrhaging."

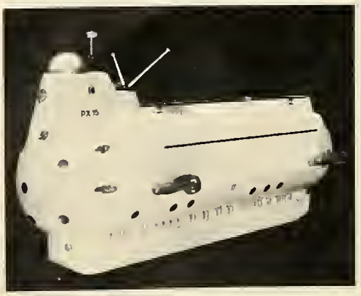
Genetic change—Panelists later discussed some of the peculiar and still not understood effects of laser destruction of malignant tumors and, in particular, the melanoma or black-pigmented tumor.

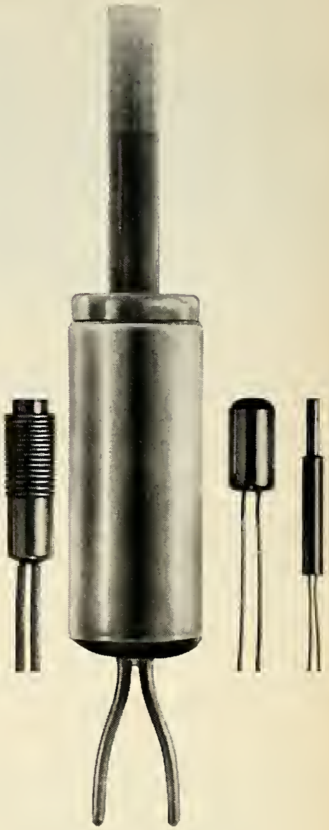
In burning off such a tumor from test mammals, it has been found that by capturing viable tumor particles in the plume emanating from the target area, the matter can be transplanted into other mammals to develop new growths. However, the new tumors that result often are non-pigmented, indicating some form of genetic transformation has taken place.

The fact that such cells survive massive laser irradiation also suggests a potential hazard for personnel working in the area. For example, what might be the ultimate effect on humans of breathing such airborne particles? The answer, apparently, is unknown. ■

Piccard URV Shown

Model of PX-15, experimental undersea research vehicle (URV) designed by Dr. Jacques Piccard and backed by Grumman Aircraft Engineering Corp. To be operational by mid-1967, the PX-15 will carry Piccard and four other scientists on a 1,500-mi. "drift" in the Gulf Stream from Miami to Halifax, N.S. Grumman will then modify the vehicle for commercial applications.





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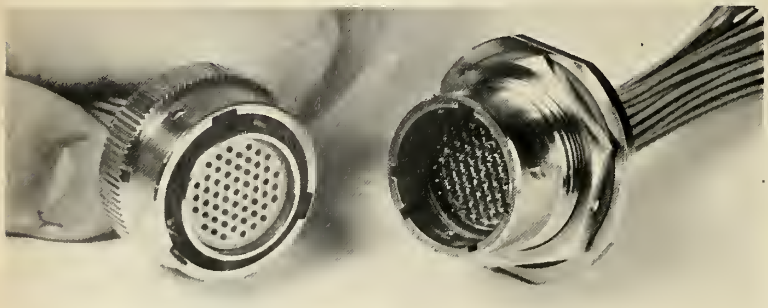

New Product of the Week: Subminiature Connector

A subminiature cylindrical connector that is claimed to combine military specification MIL-C-26500/38300 environmental performance with more than double the contact density of existing miniature connectors, has been developed by Amphenol Corp.'s Connector Div.

The Astro/348 connector features serviceable crimp contacts that are front release and rear removable, voidless internal dielectric assembly, environmental protection and standard connector hardware. The units are expected to find use in data processing equipment, aircraft, and aerospace electronics gear, communications equipment, and other applications where miniaturization is a key factor.

After crimping, contacts are inserted into the disc-dielectric and locked in place. No disassembly of the connector or feeding of wires through connector parts is required. Male pins are recessed in their shell to protect them from damage due to accidental contact with the mating shell during blind mating.

Circle No. 151 on Subscriber Service Card

Ion Gauge System

A dual-range ion gauge system that employs two ionization gauges in one system to measure pressures down to 2×10^{-11} torr has been announced by Varian Associates.

Pressures from 1 to 1×10^{-5} torr are measured with a gauge that is used for precise high-pressure readings during pumpdown for shockwave and sputtering experiments and plasma studies. It can be baked to 450°C. To cover the range from 10^{-3} to 2×10^{-11} torr, any of five ultra-high vacuum (UHV) gauges can be used for thin-film evaporators, vacuum furnaces, space-simulation chambers, electronic tube processing equipment, particle accelerators, and systems for studying surfaces. Both nude UHV gauges (bakeable to 450°C) and glass UHV gauges (bakeable to 400°C) are available.

Both log and linear scales are found on one meter. A single switch selects the gauge to be used. The emission current for each gauge is continuously adjustable and can be individually set. The gauge may be rapidly degassed by electron bombardment.

Circle No. 152 on Subscriber Service Card

Switching Discriminator

A band-switching discriminator featuring a phase-locked-loop detector has been developed by Sonex, Inc.

Model 34 is claimed to provide a high level of versatility and operational simplicity for FM multiplex systems. With 23-channel capability, it has applications in data reduction where a large number of channels is involved, or as a backup unit for a discriminator system. The device utilizes modular construction and features silicon semiconductors throughout. The discriminator, output amplifier and power-supply regulators are constructed on plug-in printed circuit cards.

Correction

M/R erred in the "Products and Processes" department in the May 23 issue. The "Temperature Controller" listed on p. 42 is manufactured by Princeton Applied Research Corp., not Applied Research Corp. We regret the error.

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Germanium Diode

A high-speed germanium diode capable of demodulating the outputs of lasers in optical communication systems operating in the 0.5 to 1.8-micron range has been developed by Philco Corp.'s Solid State Products Operation.

The Model L-4520 optical-detecting, photo-mixing diode is expected to find its greatest use with 1.06-micron neodymium lasers and 1.15-micron helium-neon lasers. Peak spectral response is 1.4 microns; light sensitive area is 0.03 sq. mm., and typical diode cut-off frequencies are 1.5 GHz. A d-c reverse bias of 6 or more volts is used to operate the diode in its most efficient high-frequency detecting mode. Typical photon efficiency is in excess of 30%. Current efficiency is greater than 85%. Coherent minimum detectable power capability is estimated as less than 10^{-16} watts.

The diode is mounted in a hermetic weld-sealed metal package. The package is assembled in a UG-88/U coaxial connector for mating with standard BNC-type connectors.

Circle No. 154 on Subscriber Service Card

Signature Analyzer

A relay signature analyzer that gives simultaneous visual displays of all dynamic switching characteristics of any relay up to 6 PDT has been introduced by Electro-Tec Corp.

The analyzer is used for design, production, inspection and testing of an a-c or d-c relay. It is available in console, standard rack or portable field models. Display is provided via any conventional oscilloscope. Custom units are also available for visual display performance of relays of 8 or more poles. The instrument can be used in comparison testing of different relays or to provide displays of relays operating under such environmental testing as high and low temperature, humidity, shock and vibration.

The unit can be used for applicable phases of Group A testing per military specification MIL-R-5757.

Circle No. 155 on Subscriber Service Card

Infrared Camera

An infrared vidicon television camera has been announced by RAM Television Products Div. of Canoga Electronics Corp.

Model CH-1070-IR permits viewing in both the visible and infrared spectrum in excess of 2 microns. It has high sensitivity and can be used to detect and observe the presence of high-purity hydrogen flame in bright sunlight and at the same time provide visible spectrum coverage of the area. Other applications include viewing the output of infrared lasers, crystal dislocations in germanium and silicon and a variety of heat distribution patterns.

Sensitivity is sufficient to image objects by their own thermal radiation at 250°. The instrument may be used to observe objects in total darkness when illuminated by infrared radiation. On a standard EIA pattern, the unit's overall system horizontal resolution is in excess of 600 lines in both the infrared and visible spectrums.

The camera contains a vidicon assembly and preamplifier. Its compact design includes filtering and shielding characteristics to prevent RF pickup and eliminate microphonics. Shock- and vibration-resistant, the instrument is of all-solid-state construction, except vidicon. It also features plug-in modules, small cylindrical design and a vidicon protection circuit.

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For example, take AAF's new line of lightweight air conditioners. They can maintain a comfortable environment in an equatorial jungle or an arctic outpost. Designed to meet the latest military specifications, these units are one-half as large and only one-third as heavy as the equipment they replace. Models are available for either 60- or 400-cycle power, in several standard sizes.

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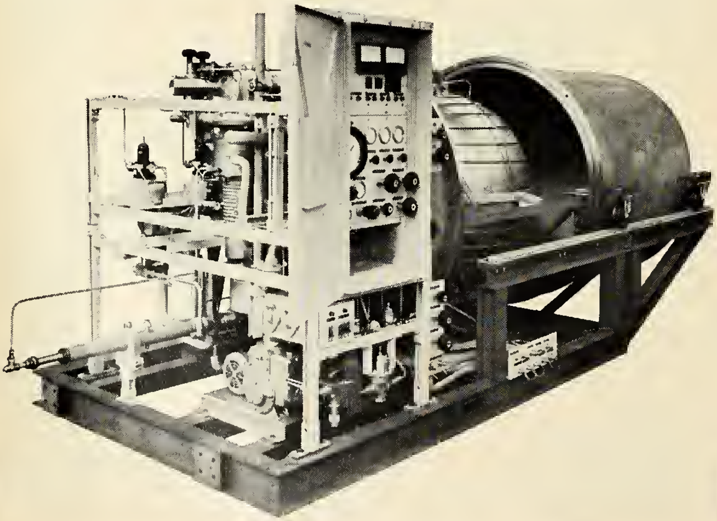

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For more information on this and other cryogenic AGE equipment for oxygen, helium, nitrogen, hydrogen, or other gases, write: AiResearch Manufacturing Division, Product Support Sales, Torrance Facility, 2525 W. 190th Street, Torrance, California.

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The Industry Week

Mergers and Acquisitions

Westinghouse Electric Corp., Pittsburgh, will purchase the assets and business of Deco Electronics, Inc., Leesburg, Va. Westinghouse will exchange common stock valued at $3.9 million. The agreement is subject to approval by Deco stockholders. The firm manufactures electronic and scientific equipment. . . . *Bendix Corp., Detroit, plans to purchase the assets and business of Scully-Jones & Co., Chicago. The move is to provide Bendix with a line of machine tool accessories to complement the firm's role in the machine tool industry, a spokesman said.* . . . Mitron Research and Development Corp., Waltham, Mass., plans to acquire 100% stock control of Rode, Inc., an investment casting company. Mitron produces equipment and products in the materials science and shock and vibration fields. . . . *Spacerays, Inc., New York City, has acquired Applied Lasers, Inc., Stoneham, Mass. Spacerays does R&D in electro-optical systems.* . . . Transonic, Inc., Bakersfield, Calif., formerly a division of Genisco Technology Corp., has been acquired by G. L. Dawson and Tom Sambrooks. Dawson was president and Sambrooks was executive vice president of the firm when it was owned by Genisco. . . . *Snap-Tite, Inc., Union City, Pa., has purchased the assets of AerValco Engineering Corp., Rosemead, Calif. Snap-Tite produces quick-disconnect couplings for fluid lines. AerValco manufactures high-pressure valves and regulators.* . . . Carco Electronics, Menlo Park, Calif., has bought the gyro test table and fluid bearing portion of the business of Wayne-George Corp., Newton, Mass.

International

Union Carbide Corp., New York City, has established three subsidiary companies as part of a management reorganization of its operations outside the U.S. The new firms are Union Carbide Eastern, Union Carbide Europe and Union Carbide Pan America. All will be headquartered in New York City. . . . *Sanders Associates, Inc., Nashua, N.H., has reached an agreement with Microwave Electronic Systems, Ltd., Scotland, to manufacture and market Sanders' microwave products.*

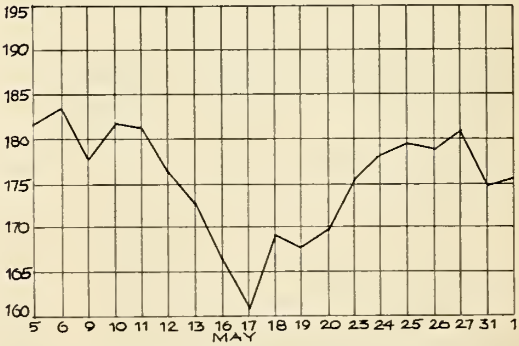
New Activities

Lockheed Missiles & Space Co., Sunnyvale, Calif., has formed a new organization to integrate the design, development and manufacture of the firm's electronics work. The organization will be headed by Harry W. Kohl, who has been named vice president and general manager—electronics. . . . *Union Carbide Corp., New York City, has established an Electronics Div. The company's present activities in the electronics field have been centered in the Linde Div. Robert A. Charpie has been named president of the new division.* . . . Honeywell, Inc., Minneapolis, has formed a Computer Group to conduct the firm's major computer activities. The company recently purchased Computer Control Co., Inc., Framingham, Mass. . . . *Technology, Inc., Dayton, Ohio, has elevated its operations in San Antonio, Tex., to the Life Sciences Div. It is the firm's first operating division.* . . . Sutton Associates, Los Angeles, has been reorganized and renamed Daton Engineering Co. The company represents several electronics firms in California. . . . *Westinghouse Electric Corp., Pittsburgh, has reorganized its atomic power division into three separate divisions. The move is to keep pace with the rapid growth of commercial nuclear power plants, a spokeman said. The new divisions are the advanced reactors division, headed by John C. Kelly, Jr.; nuclear fuel division, headed by Donald J. Povejsil; and the pressurized water reactor plant division, headed by Theodore Stern. Joseph C. Regnel has been named general manager of the three new divisions.*

Industry Facilities

Fairchild Space & Defense Systems Div. has opened a production facility at Copiague, N.Y. The 20,000-sq.-ft. building will be used for production of ordnance devices. A facility that will combine new electric computer techniques for network synthesis with the company's linear integrated circuit capability in the production of high-performance active filters has been established by Fairchild Semiconductor Div. . . . *Corning Glass Works has dedicated its new Sullivan Park research and development center near Corning, N.Y. The 450-acre park is named in honor of the late Dr. Eugene C. Sullivan, pioneer glass scientist.* . . . Westinghouse Electric Corp. will begin construction of a 167,000-sq.-ft. plant near Sykesville, Md., in June. The facility, expected to be completed in less than a year, will be used to manufacture arc-welding equipment and will employ about 250 people. . . . *The Atomic Energy Commission is establishing a Liquid Metals Information Center for gathering, evaluating and disseminating material on liquid-metals technology at Canoga Park, Calif. The center will be operated by Atomics International Div. of North American Aviation, Inc.*

Missile/Space Stock Index



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Contracts

AIR FORCE

$12,916,300—**Lockheed Missiles & Space Co.**, Sunnyvale, Calif., for launch services for the *Agena* rocket from April, 1966, to September, 1967.

$5,238,520—**Honeywell, Inc.**, Minneapolis, initial segment of a $13,096,300 contract to produce fuzes and related items.

$4,090,000—**Massachusetts Institute of Technology**, Cambridge, Mass., increment to existing contract for R&D of advanced electronics programs including space communications.

$3,600,000—**Sylvania Electric Products, Inc.**, Waltham, Mass., for development of a radio link to transfer target and firing orders from airborne control centers to *Minuteman II* missiles.

$969,900—**Goodyear Aerospace Corp.**, Akron, Ohio for *Minuteman* missile transporter.

$614,342—**General Dynamics Corp.**, Convair Div., San Diego, Calif., for integration and launch of dual orbital vehicles, *OV1-9* and *OV1-10*.

$216,000—**Sperry Rand Corp.**, Gainesville, Fla., for electronic tubes for use in downrange shipboard tracking radars.

$184,264—**Martin Marietta Corp.**, Denver Div., Denver, Colo., for study covering feasibility of utilizing a super hard *Titan II*.

$109,883—**Milgo Electronic Corp.**, Miami, Fla., for Glotrac target acquisition system.

$93,000—**Philco Corp.**, Aeronutronic Div., Newport Beach, Calif., for space electromagnetic warfare study and analysis.

$62,110—**North American Aviation, Inc.**, Space and Information Systems Div., Downey, Calif., for investigation of inadvertent firing of electro-explosive subsystems on aerospace vehicles.

$49,063—**Space and Tactical Systems Corp.**, Burlington, Mass., for development, design and fabrication of various types of a rocket and satellite power converter and associated checkout boards.

$29,800—**Kaman Aircraft Corp.**, Kaman Avidyne Div., Burlington, Mass., for vulnerability of aircraft and advanced aerospace vehicles to nuclear weapon blast and thermal effects.

ARMY

$12,656,140—**Raytheon Co.**, Lexington, Mass., five contracts for work on missiles, $1,268,383 for an engineering model of reliability monitoring equipment for *Hawk* missile; $1,410,960 for magnetron tubes for *Nike-Hercules* missile system; $1,720,797 for engineering services for the self-propelled *Hawk* missile; $3,488,000 for modification to existing contract for retrofit kits for *Hawk* missile system; and $4,768,000 modification to previously awarded contract for retrofit kits for *Hawk*.

$9,101,082—**Philco Corp.**, Philadelphia, two contracts for tooling cost and initial production of *Chaparral* air defense missile units, and to manufacture guidance and control sets for the *Shillelagh* missile system.

$5,500,000—**Sylvania Electric Products, Inc.**, Mountain View, Calif., for classified electronics equipment.

$1,470,000—**McDonnell Aircraft Corp.**, St. Louis, Mo., contract modification for engineering development for the *Medium Anti-tank Assault Weapon (MAW)*.

$205,578—**Sperry Rand Corp.**, Sperry Gyroscope Co., Great Neck, N.Y., for development of a beacon source for the *Shillelagh* missile system.

$179,697—**Thiokol Chemical Corp.**, Redstone Research Div., Huntsville, Ala., for R&D equipment and facilities in support of *Nike-X* propulsion system.

NAVY

$8,792,000—**Litton Industries, Inc.**, Guidance and Control System Div., Woodland Hills, Calif., for components of ballistic computer systems and inertial navigation systems.

$2,800,000—**Granger Associates**, Palo Alto, Calif., for high-frequency broadcast antennas to be installed at major shore communications facilities.

$1,329,000—**Nat Harrison Associates**, Miami, Fla., for construction of *Apollo* facility at Antigua, West Indies.

$178,856—**Raytheon Co.**, Missile Systems Div., Bedford, Mass., for *Sparrow II* missile system engineering and liaison for a period of 13 months.

$143,877—**North American Aviation, Inc.**, Rocketdyne Div., McGregor, Tex., for R&D feasibility of the dual area nozzle and its applicability to current and advanced Navy solid-propellant missile systems.

$143,000—**Racal Communications, Inc.**, Silver Spring, Md., for high-frequency radio ionosphere sweep frequency sounder system.

$111,688—**Stanford Research Institute**, Menlo Park, Calif., for wire-reinforced solid-propellant grain evaluation study.

NASA

$1,899,000—**Allis-Chalmers Manufacturing Co.**, Research Div., Milwaukee, from Manned Spacecraft Center for fuel cell test and evaluation program.

$459,000—**Remsco Associates**, Matawan, N.J., from Langley Research Center for increasing research capability of 20-in. mach 6 and mach 8.5 tunnels.

$400,000—**Rice University**, Houston, Tex., from Manned Spacecraft Center for suprathermal ion detector experiment for *ALSEP*.

$365,500—**Motorola, Inc.**, Military Electronics Div., Western Center, Scottsdale, Ariz., from Manned Spacecraft Center for *Apollo* unified S-band transponder test equipment.

$298,150—**Radio Corp. of America**, Astro-Electronics Div., Princeton, N.J., from Manned Spacecraft Center for design and integration study of a photovoltaic power system.

$187,630—**TRW, Inc.**, Redondo Beach, Calif., from Goddard Space Flight Center for *Nimbus* type control of configuration study. Also, $36,500 for study of mechanical shock spectra techniques for spacecraft applications.

$182,000—**Avco Corp.**, Industrial Div., Tulsa, Okla., from Manned Spacecraft Center for lunar environment simulator system.

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Names in the News

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Donald J. Lewis: Appointed director of the Research and Development Laboratory of Space Ordnance Systems, Inc. He is director of research and development.

B. Paul Barnes: Elected a member of the board of directors of Rocket Power, Inc. He is presently vice president of operations for the company.

Milton E. Mohr: Elected president and chief executive officer of the Bunker-Ramo Corp. He succeeds **Dr. Simon Ramo,** who remains a member of the executive committee and the board of directors. Mohr will continue as general manager of the company's Defense System Div.

M. L. Bandler: Named vice president of sales for Defense Electronics, Inc. He will be responsible for sale of the firm's products and systems in the U.S. and abroad.

Claude E. Munsell: Appointed engineering director of GT&E Service Corp., a subsidiary of General Telephone & Electronics Corp. He has been assistant engineering director since 1965.

Charles R. Owens: Appointed vice president for finance and treasurer at HRB-Singer, Inc. He will be responsible for the operations of the controller's department and the program negotiation department.

Anthony Sabbatino: Elected a vice president of Acoustica Associates, Inc. He has been with the company for the past seven years and served as director of marketing.

Allen M. Harrelson: Elected to the board of directors of the Bendix Corp. He is a vice president and treasurer of the company.

Dr. Lewis Larmore: Elected president of the American Astronautical Society. He is vice president of Advanced Research Laboratories for Douglas Aircraft Co., Inc.

Jeremiah E. McQuillan: Elected vice president of marketing, distribution and international of Associated Spring Corp. **John B. Beckwith** was named vice president of custom metal parts and steel. **Edwin V. Ladd, Jr.,** was elected a member of the executive committee of the board.

Robert L. Strawbridge: Elected executive vice president for Houdaille Industries, Inc. For the past three years, he was senior vice president of the corporation.

Chester W. Zakrzewski: Named division vice president of engineering of David W. Mann Co., a division of GCA Corp. He formerly was engineering department manager.

Dr. William F. Whitmore: Awarded the Secretary of the Navy Certificate of Commendation for his outstanding performance as a member of the *Polaris* Ad Hoc Group for Long Range Research and Development. He is a member of the Lockheed Missiles & Space Co.

Laurence B. Richardson, Jr.: Appointed vice president and director of marketing of the Vought Aeronautics Div. of LTV Aerospace Corp. He will be in charge of both foreign and domestic marketing operations for the division.

George Meany: Reappointed by President Lyndon B. Johnson to the board of directors of the Communications Satellite Corp.

Joseph C. Schumacher: Named to head the Rare Earth Div. for the American Potash & Chemical Corp. He is vice president of research for the company.

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When and Where

JUNE

Design & Construction of Large Steerable Aerials for Satellite Communication, Radio Astronomy & Radar, sponsored by the Institute of Electrical and Electronics Engineers, Savoy Place, London, England, June 6-8.

42nd Annual Convention of the Electronic Industries Association, Continental Plaza Hotel, Chicago, June 6-9.

11th National Plastic Exposition, sponsored by the Society of the Plastic Industry, Inc., New York Coliseum, New York City, June 6-10.

20th Annual Convention of the Armed Forces Communications and Electronics Association, Sheraton-Park Hotel, Washington, D.C., June 7-9.

Air Force/Industry Motivation Conference, sponsored by the National Security Industrial Association, International Hotel, Los Angeles, June 8.

Society of Applied Spectroscopy, National Meeting, Sheraton-Chicago, Chicago, June 12-17.

Second Cryogenic Exposition, sponsored by the Cryogenic Society of America, Inc., University of Colorado, Boulder, Colo., June 13-15.

Filmed Data & Computers Meeting, sponsored by the Society of Photo-Optical Instrumentation Engineers, U.S. Air Force Electronic Systems Div., Sheraton Boston Hotel, Boston, June 13-14.

14th Annual Technical Writers' Institute, Rensselaer Polytechnic Institute, Troy, N.Y., June 13-17.

Second Propulsion Joint Specialist Conference, sponsored by the American Institute of Aeronautics and Astronautics, U.S. Air Force Academy, Colorado Springs, Colo., June 13-17.

American Association for Advancement of Science, Seattle, June 13-18.

AGARD Lecture Series on the Application of Microelectronics to Aerospace Equipment, Nice, France, June 13-14, Delft, Netherlands, June 16-17.

Defense/Space Marketing Conference, sponsored by the American Marketing Association, Palmer House, Chicago, June 13-15.

16th Annual Earth Science Orientation Conference, sponsored by Geophysical Service, Inc., Southern Methodist University, Dallas, Tex., June 14-17.

Advanced Launch Vehicles & Propulsion Systems Conference, sponsored by the Society of Auto Engineers, Sheraton Motor Inn, Huntsville, Ala., June 14-16.

Fifth U.S. National Congress of Applied Mechanics, sponsored by the American Institute of Aeronautics and Astronautics, University of Minnesota, June 14-17.

Communications Conference, sponsored by the Institute of Electrical and Electronics Engineers, Sheraton Hotel, Philadelphia, June 15-17.

International Chemical and Petroleum Engineering Exhibition, Olympia, London, England, June 15-24.

11th Air Force Office of Scientific Research Science Seminar, Western Skies Motor Hotel, Albuquerque, N.M., June 15-22.

1966 National Symposium on Microwave Theory & Technique, sponsored by the Institute of Electrical and Electronics Engineers, Palo Alto., Calif., June 16-18.

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The Second Decade

WHEN THE SOVIET UNION put *Sputnik I* into orbit on October 4, 1957, a magazine named MISSILES AND ROCKETS already had been in existence for a full year.

In the first issue of October, 1956, Publisher Wayne W. Parrish had told why American Aviation Publications felt this industry deserved a magazine of its own: "Out of the coming conquest of space will come scientific data that will benefit the whole world. There will be advances in the fields of meteorology, flight safety, medicine, physics and many others. The possibilities are without limit."

The possibilities *were* without limit. But in what was then the aircraft industry, there were major management decisions to make before those possibilities could become realities. To some, the need to diversify into propulsion, electronics, nucleonics, missile and space vehicles was plain. North American Aviation, for example, established its Rocketdyne, Autonetics and Atomics International Divisions. Not all prime aircraft manufacturers saw the future as clearly and some, as we now know, suffered mortally from their lack of vision.

It is easy, with our ten-year hindsight, to look back and identify that major management milestone which brought the aircraft companies into what was to be the aerospace industry—where they merged their know-how with electronics firms, chemical companies and many others to develop the Space Age skills of the missile/space business.

It is not so easy, today, to see that we have arrived at another such turning point for management. In the past ten years, the industry has developed the advanced technology to send missiles arcing accurately across the Earth to predicted impact points, to send aloft incredibly complex unmanned satellites, and to set man on his journey to the Moon. Now, we are at the beginning of another era, when this advanced technology will be applied to many fields. We already see the beginnings of this in oceanology and the tentative application of some of these skills sought by the State of California in its urban problems.

We believe this marks the start of a second important decade for the industry—a decade in which the advanced technology developed in the first ten years of the Space Age will be applied to the markets of the future. We believe company management once again faces a decision of the magnitude which confronted the aircraft industry at the start of the Space Age. Decisions must be made on how best to apply this advanced technology.

Once again, the possibilities are without limit. There is need for advanced technology in weapons of land, sea and air. There is need for advanced technology in the further exploration of space. But there is also the need for advanced technology in exploring and exploiting the seas, in tackling problems of air pollution, high-speed ground vehicles, supersonic transports and other high-speed aircraft.

Aerojet-General Corp., founded as one of the pioneers of the missile/space industry, today has a contract with the Dept. of Interior to build a 50,000 gallon-per-day reverse osmosis water purification plant.

TRW Systems Group has been asked to apply its system engineering know-how to a regional land-use information system for the State of California.

A United States Senator asks, "Why can't the scientists who can cleanse instruments to spend germ-free years in space devise a method to end air pollution here on Earth?"

United Aircraft Corp. turns its knowledge of advanced technology to creation of a high-speed train. Lockheed Aircraft Corp. establishes an oceanology division and undertakes the development of advanced land vehicles.

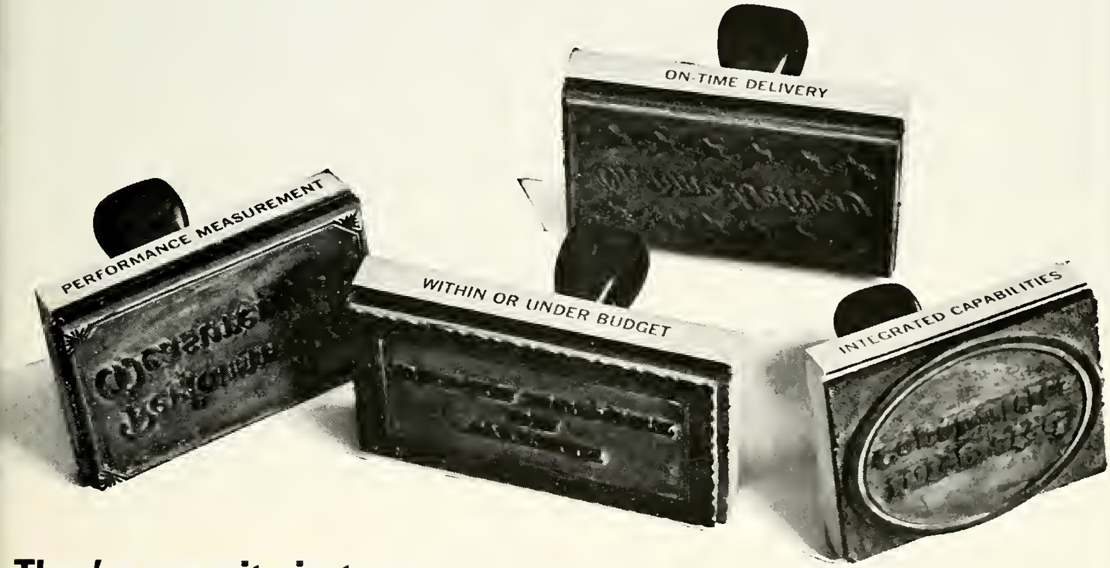
President Thomas V. Jones of Northrop sums it up when he says: "Actually, the industry that we call aerospace embraces considerably more. . . . To an increasing extent, it begins to participate in sea transport, both surface and undersea. It includes very important segments of the vast communications industry. You will find in it important activities dealing with the exploration of undersea space, desalinization of water, automatic test equipment, special purpose computers and a wide variety of other contributions to our dynamic industrial society . . . *It should more properly be known as an advanced technology industry.*"

WE AGREE with Mr. Jones. And we believe that management men everywhere in the industry must come to this same realization. The ones who acknowledge that this is indeed an advanced technology industry and that the determination required is where to apply this technology in the markets of the future are the ones who will successfully survive this coming decade.

We, the editors and publishers of MISSILES AND ROCKETS, ourselves faced this same management decision. For many months now, we have been covering activities of the missile/space industry which went far beyond the limited definition of our title. We are proud of the fact that we have won awards for such coverage. We will continue to cover space and defense activities as fully as before. But now, we believe, the time has come to acknowledge the evolution that is taking place in the industry by a change in the name of the publication that ten years ago was inaugurated to serve it. That is why, today, you hold in your hand the first issue of TECHNOLOGY WEEK, a magazine designed for the industry's second decade in the Space Age.

William J. Coughlin

Pick your criteria for judging prime contractors:



They're our criteria, too.

When we were assigned a big chunk of the Minuteman program, we knew we'd be judged by whether we delivered on time and kept within or under budget.

So we did. But it took some doing, considering that the assignments have involved completing over $200-million of research, development and production of operational hardware since 1961.

Sure we knocked ourselves out to do the job right. And satisfy the customer in cost, performance and schedules. After all, you don't get repeat business from dissatisfied customers.

It's the same no matter what standards people choose to measure us by. We live up to them.

Whether that means being a leader in implementing the "earned value" technique for Performance Measurement.

Or carving an enviable reputation as a cost-conscious company.

Or developing proven capabilities in all the disciplines needed to qualify for major systems assignments.

Do we do these things because it's good business? Sure. But only in part. Another and bigger reason is to preserve and enhance our reputation for integrity and reliability. It took us years to build, project upon project.

By developing and producing far more reentry vehicle systems than anyone else. For Atlas, Titan, and Minuteman.

By running over 170 flight tests on systems and sub-systems we developed.

By being a leading developer of penetration aids for missile systems.

Why do we go to such elaborate lengths? We have to. Because we want to go on being known as a top-notch defense contractor. So we keep at it.

By delivering the goods. According to the standards *you* establish. We figure if we continue to do this, you'll continue to give us your business.

We couldn't ask for more.

If you're a scientist or engineer with a desire to be in the advance guard where the action is, write us about yourself. We don't care about your religion, your race or where your family came from. We *do* care how you *think*.

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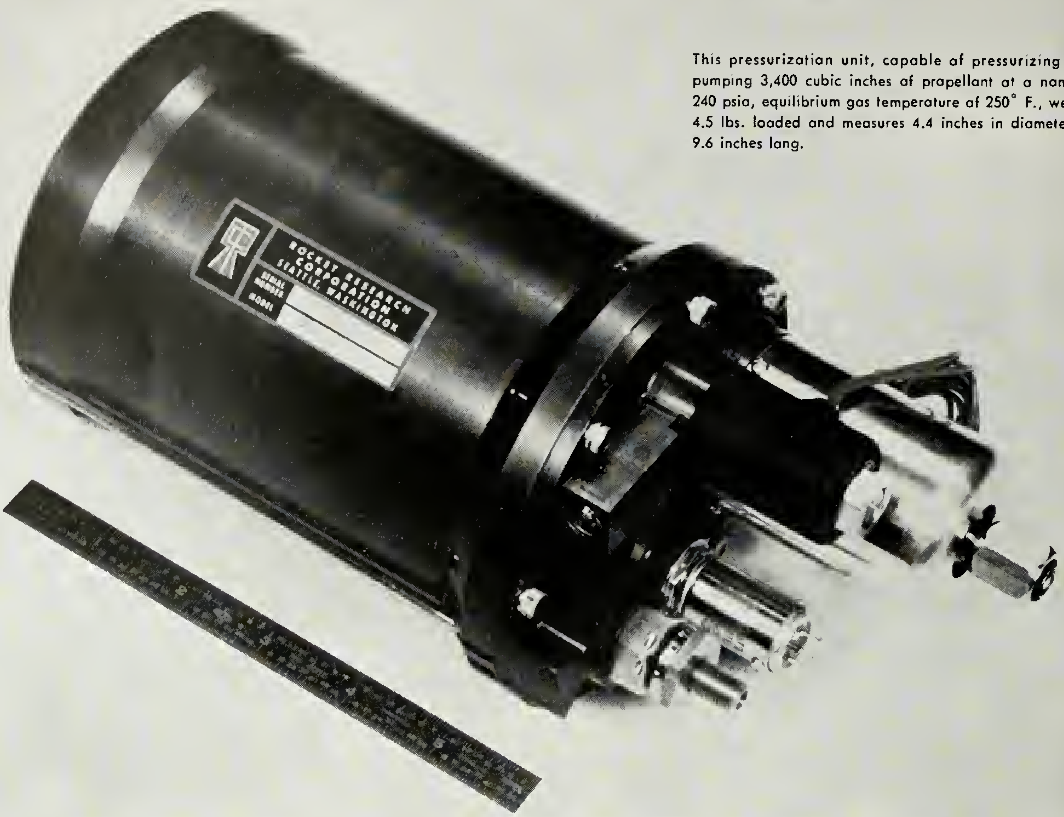

This pressurization unit, capable of pressurizing and pumping 3,400 cubic inches of propellant at a nominal 240 psia, equilibrium gas temperature of 250° F., weighs 4.5 lbs. loaded and measures 4.4 inches in diameter by 9.6 inches long.

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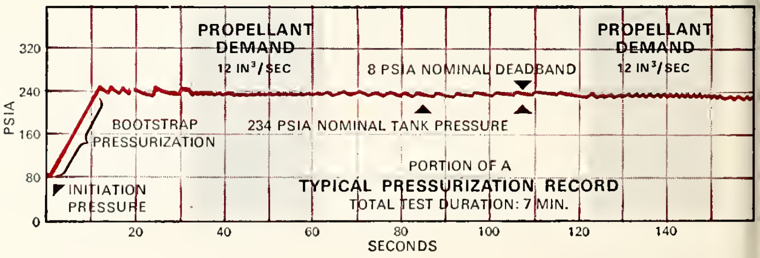
Self contained bootstrap gas generator pressurization units capable of maintaining a constant pressure in propellant tankage independent of propellant flow are now available. • These high performance units are uniquely suited to applications with design requirements of cleanliness, low weight, low volume, long term storability, and demand operation. • If you are considering the use of a high pressure stored gas pressurization system, an existing RRC gas generation unit may provide significant improvements in performance and storability. • If you are using a solid propellant gas generator and have problems with contaminated and corrosive exhaust products, temperature sensitivity and/or regulation, a monopropellant hydrazine gas generator may be the solution. The RRC pressurization units, working over a temperature range of −60°F to +160°F, provide clean, low molecular weight gases at constant pressure. Output gas temperature can be tailored to requirements over a range of 2000°F to 200°F. **The trace above,** taken from a recent test firing, graphically illustrates the pressurization capability of the Hydrazine Gas Generator under demand conditions. The test unit pressurized a 2100 cubic inch tank of water from 75 psia to 234 psia. Water was allowed to flow from the tank at regular intervals. The red trace indicates the pressurization unit automatically maintained a constant pressure of about 234 psia ± only 1.7% under the test conditions. **Other applications** for RRC gas generators include inflation, propellant expulsion, pressurization, servo system power sources, attitude control, auxiliary power systems, other pneumatic requirements for missiles, spacecraft and underwater vehicles. • *Problem solving Hydrazine Gas Generators are available now from RRC—Call Ralph Eide, Director of Marketing.*



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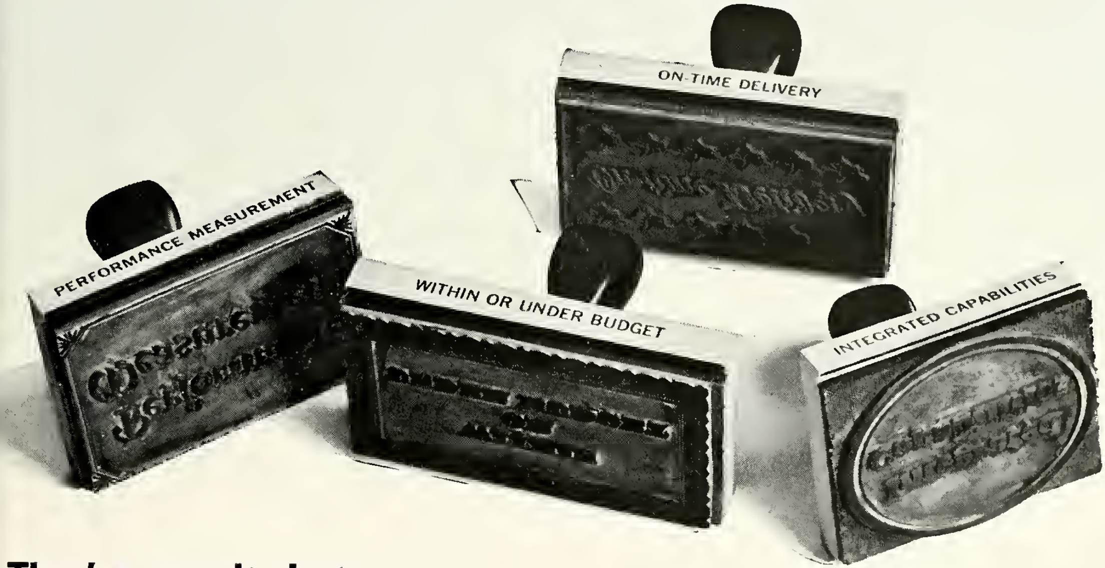

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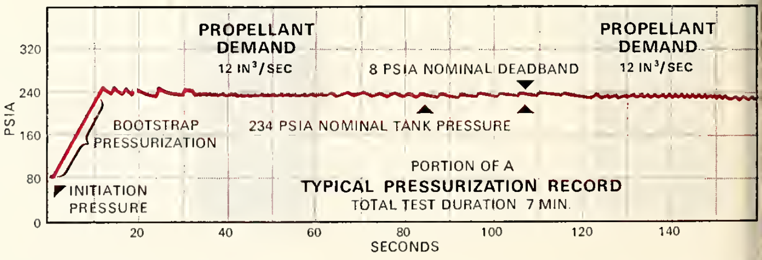

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